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REPORT OF CHATTAHOOCHEE RIVER INVESTIGATIONS FORT GAINES RESERVOIR PROJECT

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CINCINNATI, OHIO

PREPARED FOR
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Report of

CHATTAHOOCHEE RIVER INVESTIGATIONS

Fort Gaines Reservoir Project

Prepared by
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Chattahoochee River survey determines the existing quality of river water and describes the self-purification properties of the river relative to raw sewage discharges from various sources. Quantitative physical, biochemical, biological, and bacteriological information is presented to describe the current status of the river. The self-purification capacity of the Chattahoochee is established under free-flowing conditions based on existing parameters. Design criteria for treatment of wastes is based on bacterial contamination data.

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*Sewage bacteria
Sewage sludge
Chlorination
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ACKNOWLEDGMENTS

The success of a survey of this type depends to a large extent upon the cooperation of other Federal, State and local agencies and industrial firms of the region studied. This survey was aided materially by the extensive cooperation and assistance of many such agencies and firms located in or having jurisdiction over matters relating to conditions under examination in the Fort Gaines Reservoir area.

The various hydrological data and Basin information required in the study were supplied by the Atlanta District Engineer, United States Geological Survey, and the Mobile District Engineer, U. S. Army Corp of Engineers.

The State of Georgia contributed important information and assisted in making contacts for interviews with local health authorities and city officials.

Interviews with local industrial firms were arranged through the cooperation of Mr. Dixon Olive, Muscogee County Health Department. The industrial firms contacted were extremely helpful in providing information on plant operations and in supplying samples of mill wastes as required in the study.

Essential information on water supplies, sewerage and population data was obtained through the cooperation of the City Engineer, Columbus, Georgia; the Post Engineer, Fort Benning; and the Superintendent of Utilities, Eufaula, Alabama.

The Georgia Power Company Plant operators provided various hydrological data pertinent to river sampling procedures.

Assistance of particular importance was provided by the Water Improvement Commission, State of Alabama, which arranged for the location of the mobile laboratory at Phenix City. Various details relative to laboratory space and facilities at Phenix City were arranged through the courtesy of Mr. G. E. White, General Manager of the Gas and Water Department, and were provided very capably by Mr. D. R. McLamore, Superintendent of the Phenix City water filtration plant.

SUMMARY

1. At the present time the major water use of the Chattahoochee River within the Fort Gaines impoundment area is for disposal of untreated municipal and industrial wastes.
2. Limited use is made of the proposed impounded area for fishing and boating or other forms of recreation.
3. The quality of Chattahoochee River water immediately above Columbus and Phenix City is within the raw water quality group recommended in Public Health Bulletin No. 296 as suitable for public water supplies requiring treatment by conventional methods.
4. The quality of Chattahoochee River water from Columbus to Fort Gaines, Georgia, is not within the raw water quality groups recommended in Public Health Bulletin 296 as suitable for public water supplies requiring treatment by conventional methods.
5. Raw sewage discharges to the Chattahoochee River from Columbus and Phenix City cause unsanitary and nuisance conditions in local residential, business and recreational areas between Columbus and Fort Benning; and create polluted water characteristics from Columbus to Fort Gaines, Georgia.
6. Pollution characteristics produced by sewage and industrial waste discharges to the Chattahoochee River from Columbus, Phenix City and Fort Benning sources are particularly apparent during low flow stages of the river and hot dry weather.

7. Approximately ninety per cent of the domestic sewage from Columbus (100% sewered) and fifty-five per cent of the sewered population from Phenix City (70% sewered) is discharged directly to the Chattahoochee River below the Eagle Phenix Dam.
8. Industry contributes approximately fifteen per cent of the total pollution load from the Columbus and Phenix City area.
9. Additional pollution loads corresponding to predicted future population growth in the Columbus and Phenix City area will further reduce the quality of Chattahoochee River water within the Fort Gaines impoundment area.
10. Based upon the design flow of 600 cfs and at water temperatures of 28° Centigrade, thirty-five per cent BOD removal from all major sources of pollution now existing in the Columbus, Phenix City and Fort Benning area is necessary to maintain a 4.0 parts per million minimum dissolved oxygen objective.
11. Based upon the design flow of 600 cfs and at water temperatures of 28° Centigrade, seventy-five per cent BOD removal of the predicted 1977 Columbus and Phenix City pollution loads, together with thirty-five per cent BOD removal of the Fort Benning loads, would be needed to maintain a 4.0 parts per million minimum dissolved oxygen objective.
12. Based upon Chattahoochee River water quality data at Eufaula, Alabama, thirty-five per cent BOD removal (primary treatment) of

Eufaula sewage with effluent chlorination would protect downstream users and reduce the threat of bacterial contamination of Apalachicola Bay oysters.

13. Bacterial contamination of the Chattahoochee River from Columbus to Fort Gaines, Georgia, could be greatly reduced by treatment, including effluent chlorination, of Columbus, Phenix City and Fort Benning sewage.

INTRODUCTION

This survey of the Chattahoochee River was made by the Public Health Service in connection with the Fort Gaines Reservoir Project at the request of the Mobile District Engineer, Corps of Engineers, U. S. Army. It was conducted during the months of September and October 1957, and August and September 1958. The section of the Chattahoochee River under investigation is that included between Mile 75, the site of the Fort Gaines Dam, and Mile 170 (Figure 1 of Appendix I, Survey Sampling Stations and Landmarks) which is immediately above the Columbus, Georgia, and Phenix City, Alabama, metropolitan area. The survey was undertaken to determine and document the existing quality of the river water throughout this section and to describe the self-purification properties of the river relative to raw sewage discharges from Columbus, Georgia, Fort Benning, Georgia, and Phenix City and Eufaula, Alabama.

Objectives of the Survey

1. To present quantitative physical, chemical, biochemical, biological, and bacteriological information as a means of describing the general quality of the Chattahoochee River as it presently exists.
2. To establish the self-purification capacity of the river under free flowing conditions based upon existing parameters.
3. To present data upon which to base design criteria for treatment of wastes that may be desirable under present conditions, or in the future as a result of population increases and industrial expansion.

CHATTAHOOCHEE RIVER
COLUMBUS TO FORT GAINES, GA.

EXHIBIT A

DESCRIPTION

The Area

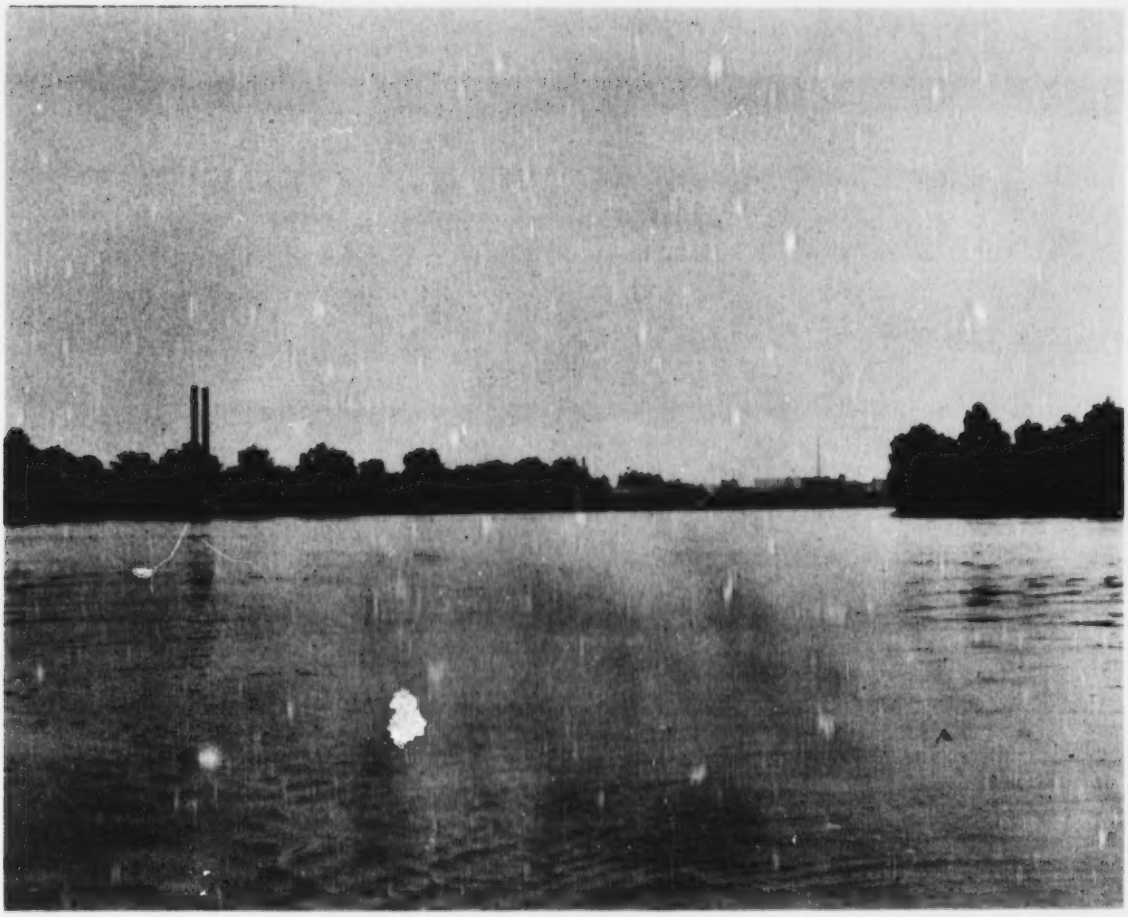
The section of the Chattahoochee River Basin under examination is that portion lying between Fort Gaines and Columbus, Georgia, a distance of approximately eighty-five river miles.

The west bank of the Chattahoochee River forms the western border of Georgia and eastern border of Alabama throughout this section. Population centers involved in the State of Georgia are Columbus, Fort Benning and Georgetown and those in the State of Alabama are Phenix City and Eufaula. The city of Fort Gaines, Georgia, is not considered in the survey since it is located below the Fort Gaines Dam site. (See Exhibit A, Map, Chattahoochee River - Columbus, Georgia, to Fort Gaines, Georgia.)

Physical Features

The Chattahoochee River at Columbus has a drainage area of 4,670 square miles. An additional 2,837 square miles drain into the river between Columbus and the Fort Gaines Dam site. The average discharge at Columbus is 6,480 cfs. The maximum known discharge on record is 198,000 cfs and the minimum daily known discharge is 480 cfs.

River flows at Columbus are affected by releases from the Georgia Power Company Dams located upstream. The dams operate on a variable schedule which depends upon the natural flow of the river. At low flow the Georgia Power Company usually passes greater than



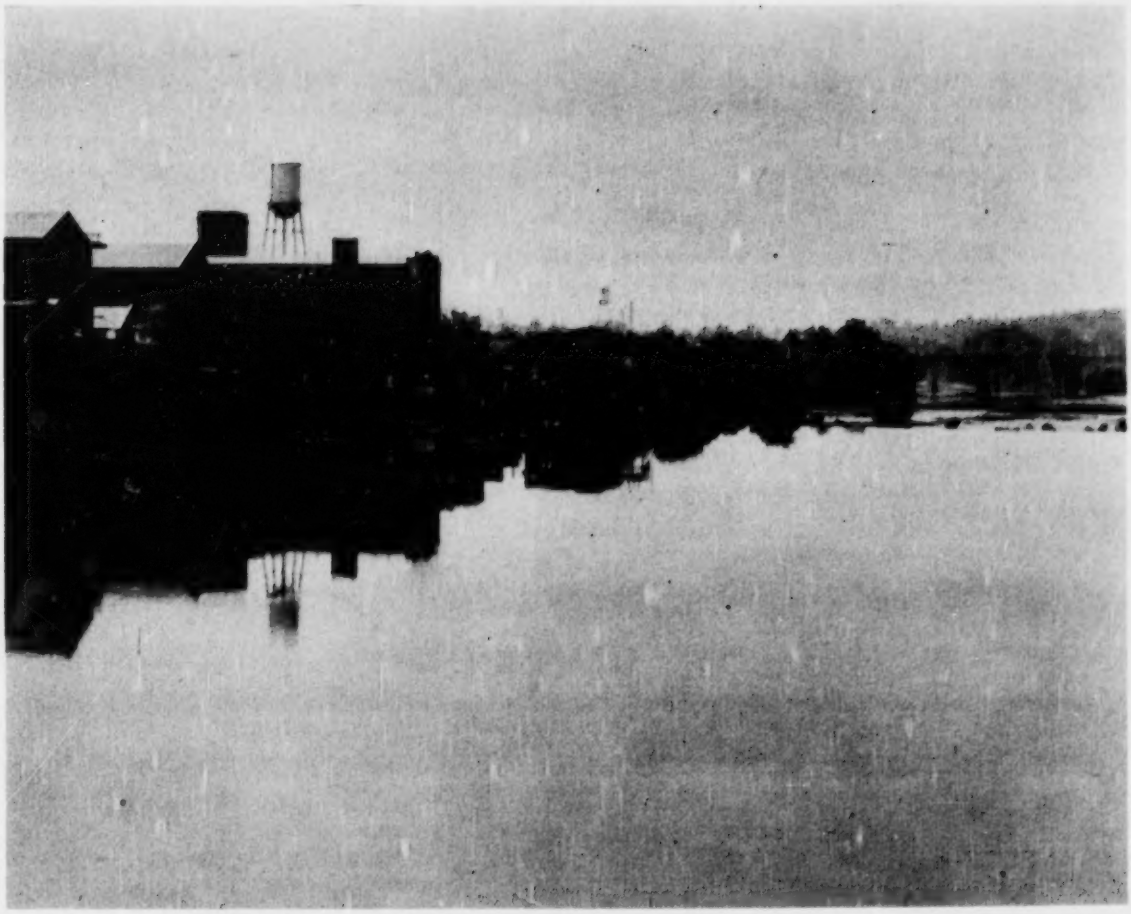
CITY MILLS IMPOUNDMENT, SHOWING THE PERSPECTIVE OF THE CHATTAHOOCHEE RIVER IN THE IMMEDIATE VICINITY OF COLUMBUS, GEORGIA AND PHENIX CITY, ALABAMA. (LOOKING DOWNSTREAM)

ILLUSTRATION I

natural river flow through the dams. The minimum flow objective for the dams is approximately 800 cfs.

The Georgia Power Company is at present constructing another dam, to be known as Oliver Dam, at about Mile 170. Immediately below the Oliver Dam site is a series of three low dam impoundments. These impoundments extend to approximately Mile 160.5 which is about the mid point of the Phenix City and Columbus city limits and is the extreme headwater of the Fort Gaines impoundment area. In order of sequence downstream, these dams are: the North Highland Dam, City Mills Dam and the Eagle Phenix Dam. Velocities of the river through these impoundments during relatively low flow (1,700 cfs) are in the magnitude of approximately 0.2 to 0.35 feet per second.

Below the Eagle Phenix Dam the river becomes a free flowing stream with no further major obstructions throughout the eighty-five miles under examination. However, within the upper one third of this eighty-five mile section the velocity of flow near the shore is partially checked by numerous rows of piling located along various straight stretches of the river. During mean low flow the elevation of the Chattahoochee River at the Eagle Phenix Dam is 190 feet. From this point the average slope to the Fort Gaines Dam site is approximately one foot per mile. At the median low flow (1,700 cfs) encountered in this survey the individual slopes existing within the first fifteen miles below the Eagle Phenix Dam produced velocities in the magnitude of 0.9 to 2.3 feet per second.



EAGLE PHENIX IMPOUNDMENT, COLUMBUS, GEORGIA, SHOWING THE LOCATION AT THE FARTHEST DOWNSTREAM TEXTILE MILL IN RELATION TO THE FREE FLOWING REACH OF THE CHATTAHOOCHEE RIVER BELOW

ILLUSTRATION 2

The Chattahoochee River at Columbus and Phenix City falls approximately seventy feet in stepwise fashion as provided by the three dams. Within this section, a distance of approximately three miles, the river is contained between high banks ranging from thirty to fifty feet. With the exception of a short section along the Columbus side of the river where two large textile mills are located, the banks are covered by scrub trees and thick underbrush.

Below Columbus, the banks are also steep and high attaining the eminence of bluffs in some places. For instance, Eufaula, Alabama, is sometimes referred to as the Bluff City. The course of the river is characterized by unusually long and straight reaches through the middle of the valley. The river bottom consists mainly of sand and gravel. The sand or gravel bars at tributary creeks and along the shore areas indicate a continually shifting bottom.

The major tributaries and respective drainage areas concerned in this survey are as follows:

Tributary	Drainage from	River Mile	Drainage Area sq. mile
Bull Creek	Georgia	157.0	75 (Approx.)
Upatoi Creek	Georgia	150.2	451
Uchee Creek	Alabama	142.0	334
Hichitee Creek	Georgia	132.0	55 (Approx.)
Hannahatchee Creek	Georgia	121.1	150
Hatchachubbee Creek	Alabama	118.6	151
Cowikee Creek	Alabama	105.6	464
Barbour Creek	Alabama	93.2	97

Sanitation

There is no central collection or treatment of sewage in the metropolitan area of Columbus, Georgia, and Phenix City, Alabama. Wastes are discharged directly to the Chattahoochee River from individual collection lines serving various parts of the two cities. This has resulted in the existence of numerous outfalls discharging raw sewage along the banks of the river for a distance of approximately five miles. At many locations sewage is discharged down the slopes of the river banks through deep cut gullies to the river. Sewage solids, paper and other debris cling to the undergrowth and accumulate at various points between the outfall and the river. Sewage odors emanate from these sewage laden gullies to the extent that many areas along the river, including Columbus and Phenix City business districts, are affected. Many sewers in the area carry a combination of raw sewage and storm drainage. This type collection system produces additional odors from sewer gases being released to the atmosphere at various storm drainage points along the city streets.

Sewage entering the impounded section of the Chattahoochee River does not readily mix with the main flow of the river but instead remains relatively concentrated along the edges until passage over the dams to the free flowing streams below. Debris and discolorations by wastes from sewers and textile mill outfalls have been observed for a considerable distance below these respective discharges.

It is apparent that sewage accumulations along the banks and edges of the Chattahoochee River throughout the Columbus and Phenix City

EAGLE PHENIX DAM, COLUMBUS, GEORGIA AND PHENIX CITY, ALABAMA, SHOWING LOCATION OF INDUSTRIES AND PERSPECTIVE OF THE CHATTAHOOCHEE RIVER BELOW THE DAM DURING A LOW FLOW STAGE.

ILLUSTRATION 3

area are suitable as breeding places for insect vectors of disease. Flies and mosquitoes are in evidence and cockroaches are especially abundant in the sewer manholes and outfalls.

The greater percentage of Columbus and Phenix City sewage is discharged to the Chattahoochee River below the impounded reach. The sewage discharged along this section of the river apparently provides abundant food for fish which in turn are caught and eaten by local citizens. It is commonplace to find people fishing at points of sewage discharge along the river. Details on sewage discharged and effects of these waste loads on the quality of river water are given in a later section of this report.

Concentrations of raw sewage and waste materials occur similarly in the immediate areas of the Chattahoochee River downstream of Fort Benning sewer outfalls and the Eufaula, Alabama, sewer outfall. Waste debris and solids settle in quiescent pools or deposit on the edges of the river by wave action and/or during falling river stages. Nuisance odors are especially apparent in these outfall areas. Boating, fishing or other contact with the river in these areas can be a detriment to public health.

TYPICAL RIVER SCENE ON THE CHATTAHOOCHEE RIVER NEAR EUFAULA, ALABAMA
ILLUSTRATION 4

SURVEY METHODS

The greatest emphasis of the 1957 and 1958 survey was given the section of river from the Central of Georgia Railroad Bridge at Columbus, which is to be the extreme headwater of the Fort Gaines Reservoir, to various points within and below the Fort Benning Military Reservation. Additional sampling points below this section were selected in order that existing water quality and an estimation of self-purification and assimilation of waste loads introduced above might be evaluated.

Variable flows were encountered as a result of periodic releases of water from the Goergia Power Company Dams above Columbus. In addition, the 1957 survey was somewhat hampered by variable weather conditions causing rather extreme and abrupt fluctuation in river flows and temperatures. However, for the first two weeks of the 1957 portion of the survey, almost ideal low flow conditions existed. Most of the composited data used to derive deoxygenation and reaeration velocity constants* in the river were collected at this time. Various heavy rains followed the dry period enabling collection of data during rising, falling and steady stages. Data collected during these periods reflect flushing and scouring conditions, the extent of

* Used in computing the extent of water quality degradation and recovery associated with assimilation of organic waste loads at various flow stages.

which is shown in a later section. Conditions during the 1958 survey were much improved over those of 1957, except that minimum river discharges encountered were consistently higher.

The shallowness of the river during low flows prohibited use of outboard motorboats for making upstream return sampling runs. Because of this, sampling points were established at locations which were most accessible as boat launching points from the banks of the river. Due to higher flows in 1958, motorboats were used exclusively and the same major points sampled in order to be consistent in rechecking the prior year's results. Several additional points were sampled in 1958 for the purpose of determining cross-sectional waste load distribution and for locating downstream points where cross-mixing of waste loads was complete. (See Appendix I, Figure 1a.)

The laboratory work was done in a mobile laboratory unit located at the Phenix City filtration plant. Samples were analyzed for dissolved oxygen, biochemical oxygen demand, suspended solids, alkalinity, hydrogen ion concentration and most probable number coliform organisms.

Biological examinations of the river were made. These examinations included an evaluation of conditions existing on the riverbed and a study of the relative abundance of plankton (minute free-floating aquatic life) as observed at various points along the river above and below the sources of pollution.

PRESENTATION OF DATA

Water Uses

Municipal Water Supplies

Columbus, Georgia

The City of Columbus, Georgia, obtains water for domestic use from the Chattahoochee River at a point immediately above the Oliver Dam site. Complete treatment is given the water, including chlorination. During 1956 the total finished water produced was slightly over five billion gallons. Average use of water for the months of July, August, and September 1957 was 19.4, 21.9 and 16.3 MGD, respectively. Maximum uses for the months of July, August, and September 1957 were 26.6, 26.7, and 25.3 MGD, respectively. Approximately 15% of water produced by Columbus is used for commercial purposes. Over 130,000 people are served by the Columbus plant. The per capita comsumption of water is approximately 150 GPD.

Phenix City, Alabama

Phenix City, Alabama, obtains water from the Chattahoochee River at a point about two hundred yards above the North Highland Dam; complete treatment including chlorination is given this water. Total finished water produced by Phenix City during 1957 was approximately 500 million gallons. For the months of July, August, and September 1957 the finished water produced was 54.6, 61.6 and 47.5 million gallons, respectively. During the month of September 1957 the average,

maximum and minimum production of water was 1.6, 2.7 and 0.9 MGD, respectively. Approximately 98% of water produced by Phenix City is for domestic use. The daily per capita consumption of water is approximately 70 gallons.

Fort Benning, Georgia

Fort Benning obtains its water supply from a low head dam on Upatoi Creek. The elevation at the crest of the dam is 194 feet. Complete treatment is given the Fort Benning water supply. During the months of September and October 1957 water usage by Fort Benning amounted to 5.5 and 5.0 MGD, respectively. Consumption during June and July 1958 was 6.9 and 6.7 MGD, respectively. Per capita consumption at Fort Benning ranges from approximately 155 to 175 GPD.

Eufaula, Alabama

Eufaula, Alabama, obtains water from Barbour Creek and from one well. In August 1957 the city used approximately 20 million gallons. The average monthly usage of water by Eufaula is about 16 million gallons. The planned pool elevation of the Fort Gaines Reservoir is higher than the present elevation of the Eufaula water supply dam on Barbour Creek.

Georgetown, Georgia

Georgetown, Georgia, obtains water from wells. Because of the small size of this community no figures on water usage were obtained.

Industrial Water Supply

Manufacturing

The main industrial use of water in the Columbus area is in the manufacture of textile goods. The textile manufacturers produce finished goods which require fairly large quantities of process water. Two mills obtain water directly from the river and apply treatment with their own facilities. The usage of water from this source is approximately 3.5 MGD. Various other industries throughout the area use approximately 15% of the total Columbus water production, or about 4.0 MGD. The total industrial use of water for other than power production is in the magnitude of 7.5 MGD.

Power Production

Seven dams for hydroelectric purposes, all interstate in location, have been built along less than 40 miles of river between West Point, Georgia, and Columbus, Georgia. In addition, the Oliver Dam, upstream from North Highland Dam, is currently under construction.

Recreation

Recreational developments at present are limited. Bartletts Ferry Reservoir above Columbus, Georgia, has been rather extensively developed with swimming, fishing and boating as the major recreational attractions. The river, where not impounded, has a high velocity which makes swimming and boating dangerous.

During this survey, it was observed that the Chattahoochee River below Columbus was used by various individuals for fishing purposes. At times as many as 20 fishermen were observed between the Central of Georgia Railroad bridge and Bull Creek, and about the same number between Bull Creek and Eufaula, Alabama.

Present Pollution Sources and Loads

Upstream Pollution Loads

The following are pollution loads and points of entry of these loads into the Chattahoochee River from Mile 251.3 to the Columbus, Georgia, and Phenix City area.

River Mile	Entry to Chattahoochee River	Source of Load	Population Equivalent
251.3	Wahoo Creek	Sargent	800
226.9	New River	Grantville	500
		Newnan	3,000
215.8	Yellow Jacket Creek	Hogansville	3,500
202.0	Osilgee Creek	Lafayette	800
201.0	Direct	West Point	1,500
199.0	Direct	Larrett	5,600
199.0	Direct	Larrett Mills	50,000
198.0	Long Cane Creek	LaGrange	18,000
195.5	Direct	Longdale	100

(Continued on next page)

River Mile	Entry to Chattahoochee River	Source of Load	Population Equivalent
193.0	Direct	Longdale-Shawmut	4,450
189.7	Direct	River View	Unknown
189.2	Osanippa Creek	Fairfax	2,500
189.2	Osanippa Creek	Fairfax Mills	13,800

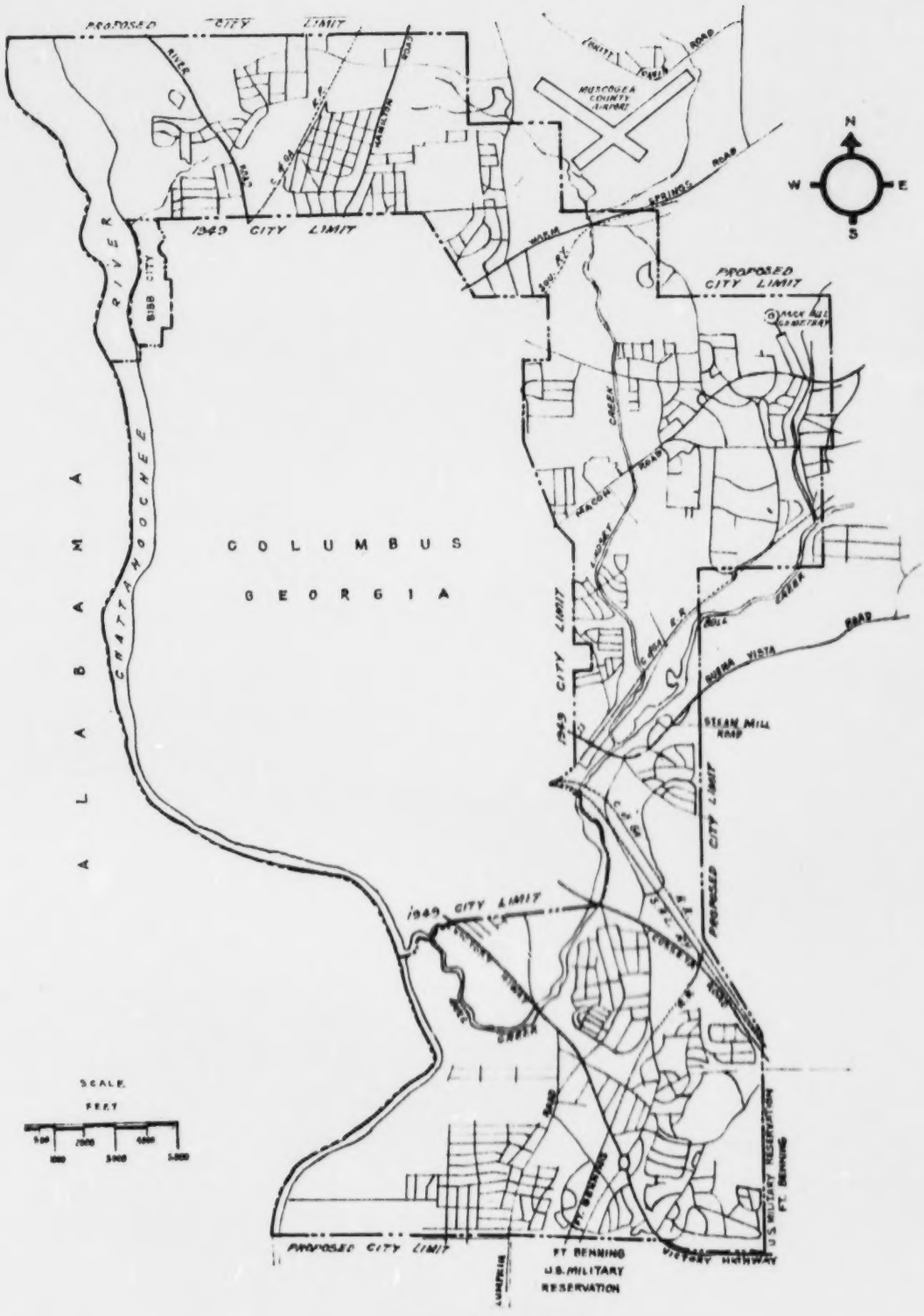
Columbus, Ga., and Phenix City, Ala., Pollution Loads

At Columbus and Phenix City a population load of approximately 186,000 is discharged into the Chattahoochee River between Mile 163 and Mile 157. All waste is discharged untreated. About ten per cent of this load is discharged into the impounded sections of the river and ninety per cent into the free flowing section from the Eagle Phenix Dam downstream to Bull Creek, or Mile 157.

The following is a breakdown of this population load:

Source of Load	Entry to Chattahoochee River	Population
City of Columbus	Direct	101,000
Bull Creek Area	Bull Creek and Direct	25,000
South Area	Direct	2,000
Industry	Direct	* 30,000
Phenix City	Direct	28,000
	Total	186,000

* Population Equivalent



COLUMBUS, GEORGIA
Proposed 1959 Annexation

EXHIBIT B

There are thirty-one sewer outfalls throughout this area. Nine of these outfalls are on the Phenix City side of the river and twenty-two are on the Columbus side.

During 1957 and 1958 the County of Muscogee constructed a thirty-inch interceptor sewer which serves a large section of the South Columbus and Bull Creek Area. This interceptor discharges to the Chattahoochee River approximately 500 feet below the mouth of Bull Creek.

In 1959 the Columbus City limits are to be extended to include the South Area to the Fort Benning Reservation and north and east to include the Bull Creek Area and North Area. This will almost double the 12.6 square miles now existing within the city limits of Columbus. The estimated total population of Columbus after annexation will be approximately 130,000. (See Exhibit B, Map, Columbus, Georgia, Proposed Annexation.)

Fort Benning Military Reservation Pollution Load

The population at the Fort Benning Military installation is estimated to vary from 20,000 to 80,000. During the 1957 and 1958 surveys the estimated army and civilian personnel occupying the post was 30,000 and 36,500, respectively. Population estimates on the basis of present group housing facilities represent a population of approximately 72,000. The population on a mobilization basis is slightly greater than 80,000. The ultimate permanent population of the Fort Benning Reservation is estimated at 60,000.

The following is a summary of the present disposal facilities at the Fort Benning Military Reservation:

Area(1)	*Present Contributory Population(1)	Treatment	Entry Chattahoochee River
Harmony Church	16,800	Complete** (unchlorinated)	Mills Creek to Oswichee Cr.
Sand Hill	20,090	None	Direct No. Side Upatoi Cr.
Kelly Hill	5,610	None	Direct So. Side Upatoi Cr.
Main Post	29,880	None	Direct (5 interceptors)
Total	72,380		

* Based upon peacetime space requirements

** Eight hour day operation, serves 6 - 8% of base personnel.

Approximately 80% of the Fort Benning load enters the Chattahoochee River between Miles 151 and 148. The remaining 20% enters at Mile 145.

Downstream Pollution Loads

River Mile	Entry into Chattahoochee River	Source of Load	Population
107.0	Cowikee Creek	Huntsboro	750
100.2	Patula Creek	Cuthbort	1,200
100.2	Patula Creek	Lumpkin	650
97.5	Direct	Eufaula	4,000

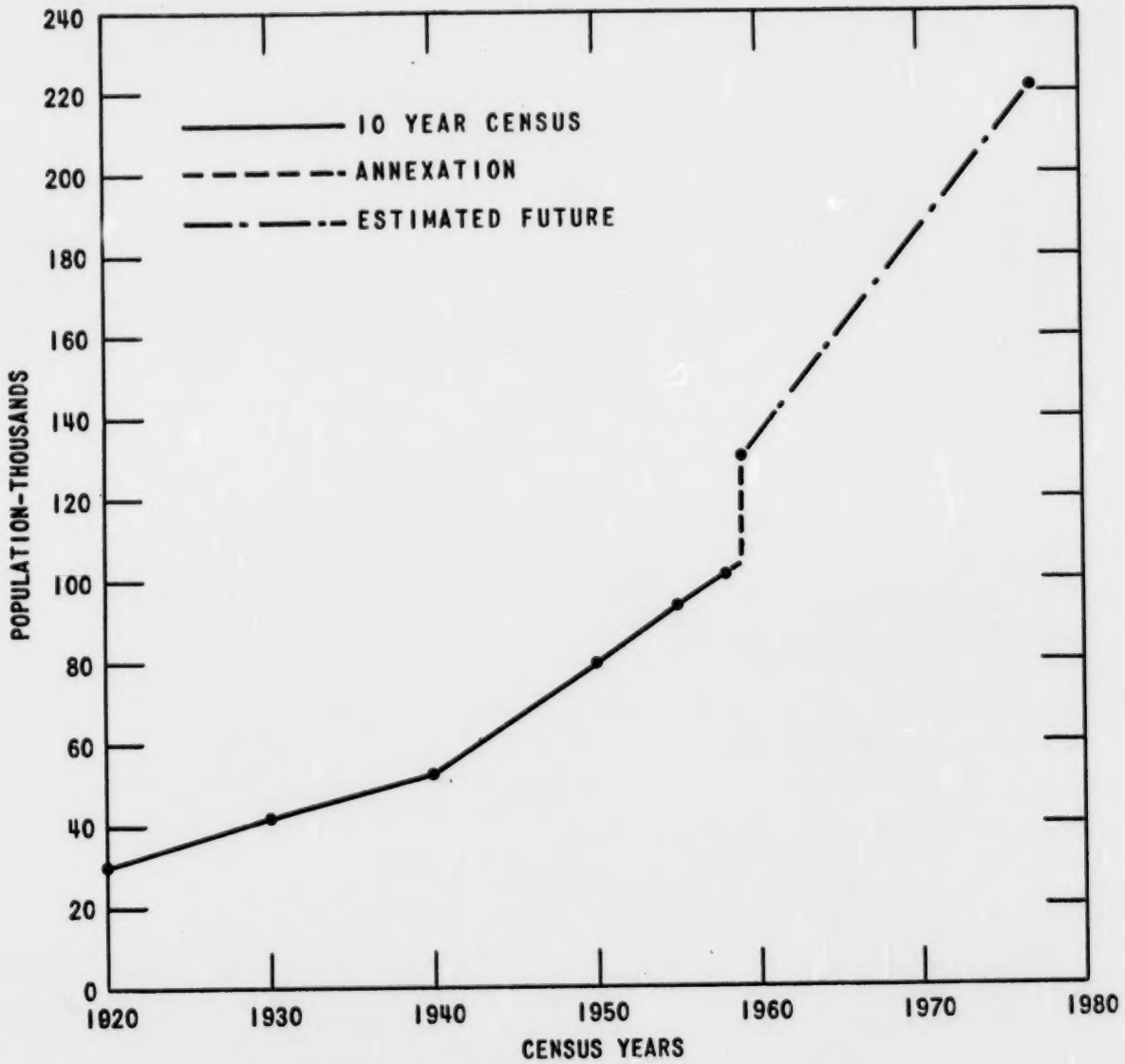
Future Pollution Loads

It is estimated that by 1977 the sewered population of the Columbus and Phenix City area will have risen to a total of 267,000. This amounts to an approximate forty per cent increase in the Columbus sewered population and fifty per cent increase of the Phenix City population. This total does not include industrial loads now existing nor does it include possible additional loads resulting from industrial expansion. Assuming a factor of (1.5) as a multiple of the existing industrial load, an additional 45,000 equivalent population would be added bringing the potential 1977 sewered population total to 312,000.

The following is a breakdown of the estimated 1977 sewered population in the Columbus, Georgia and Phenix City, Alabama, area.

Source of Load	Population
Area North of Columbus	32,000
City of Columbus	103,000
Bull Creek Area	82,000
Area South of Columbus	5,000
Phenix City	45,000
Industry	45,000
Total	312,000

Note: After the 1959 annexation the 1977 Columbus population would be 222,000.
(See Exhibit C, Columbus, Ga. population growth.)



COLUMBUS, GEORGIA POPULATION GROWTH
YEARS 1920-1977

EXHIBIT C

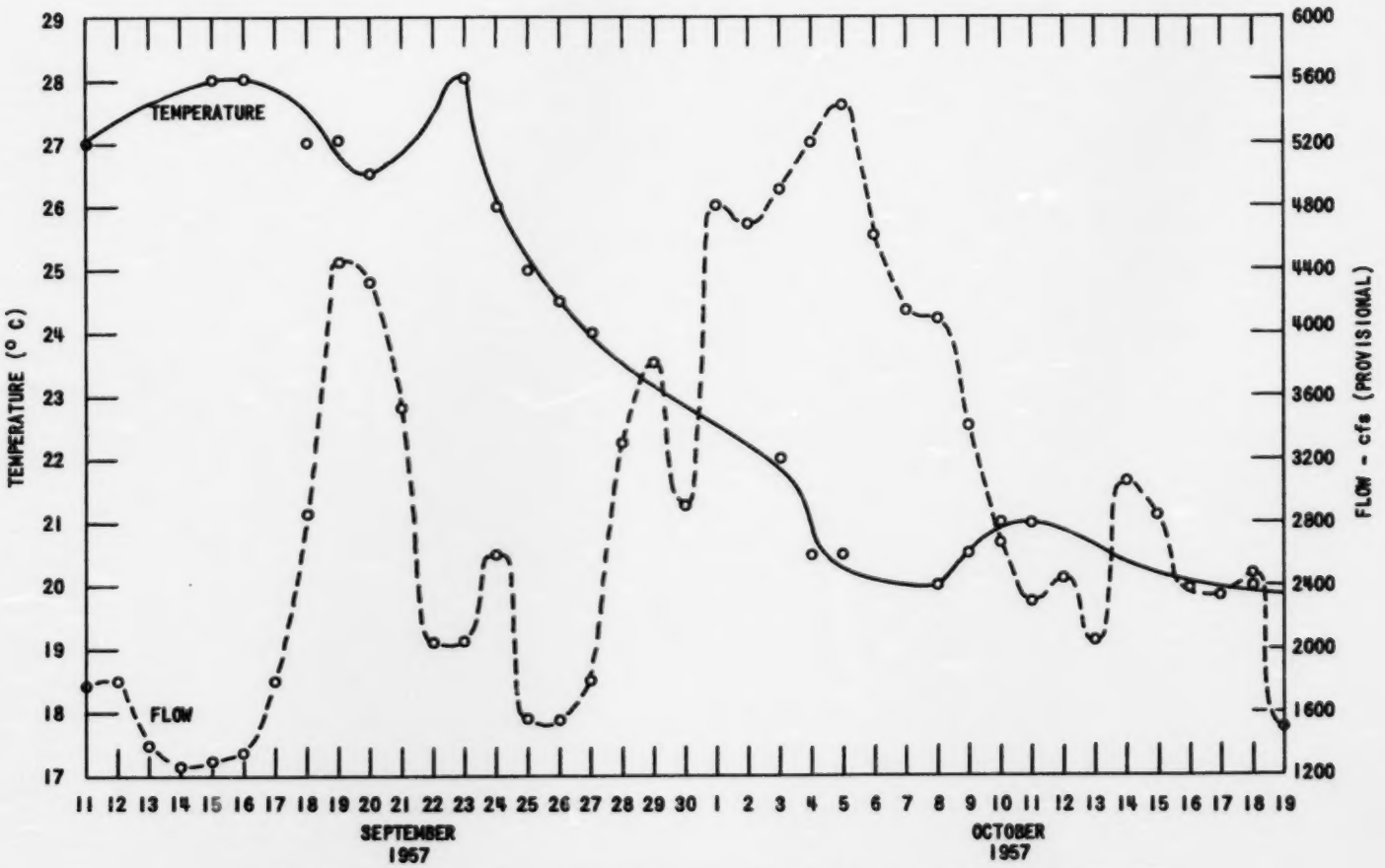
Description of General Quality and Characteristics of the Chattahoochee River

Physical Conditions

The mean daily flows and corresponding temperatures experienced during the survey are shown in Figure 2. The flows shown are those obtained from daily gauge height tracings and calibrations at the U.S.G.S. gauge station at the Central of Georgia Railroad bridge, Columbus, Georgia. These flows do not reflect the increment tributary increases added to various downstream sections. The temperatures shown are averages of readings taken approximately every four hours and correspond to samples collected at the same time.

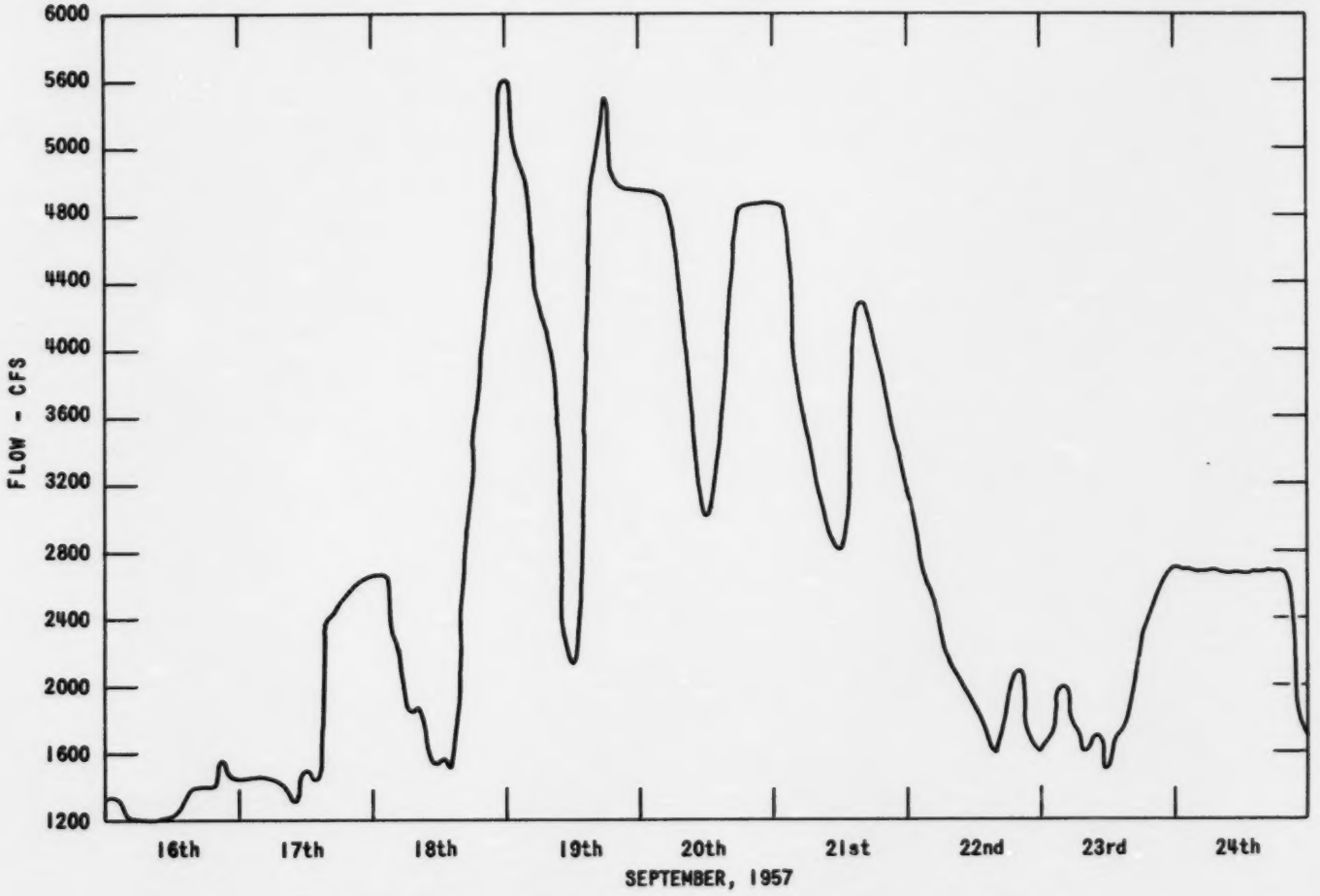
Daily fluctuations in flow during a relatively low flow period of the survey are typified in Figure 3. These variations were due mainly to releases made at the upstream dams.

Data collected during stages of relatively rapid rises in flow gave indications of the magnitude of flushing and scouring at times during the survey. As flows increased in excess of approximately 3,500 cfs following a sustained low flow period, a decided increase in suspended solids was observed. In addition to the usual solids material contained in run-off water, it is believed that a considerable portion of the solid material originated in the impounded section of river. Upon sustained flows of 3,500 cfs and higher the suspended solids content gradually reduced, indicating completion of heavy flushing. Figure 4 shows



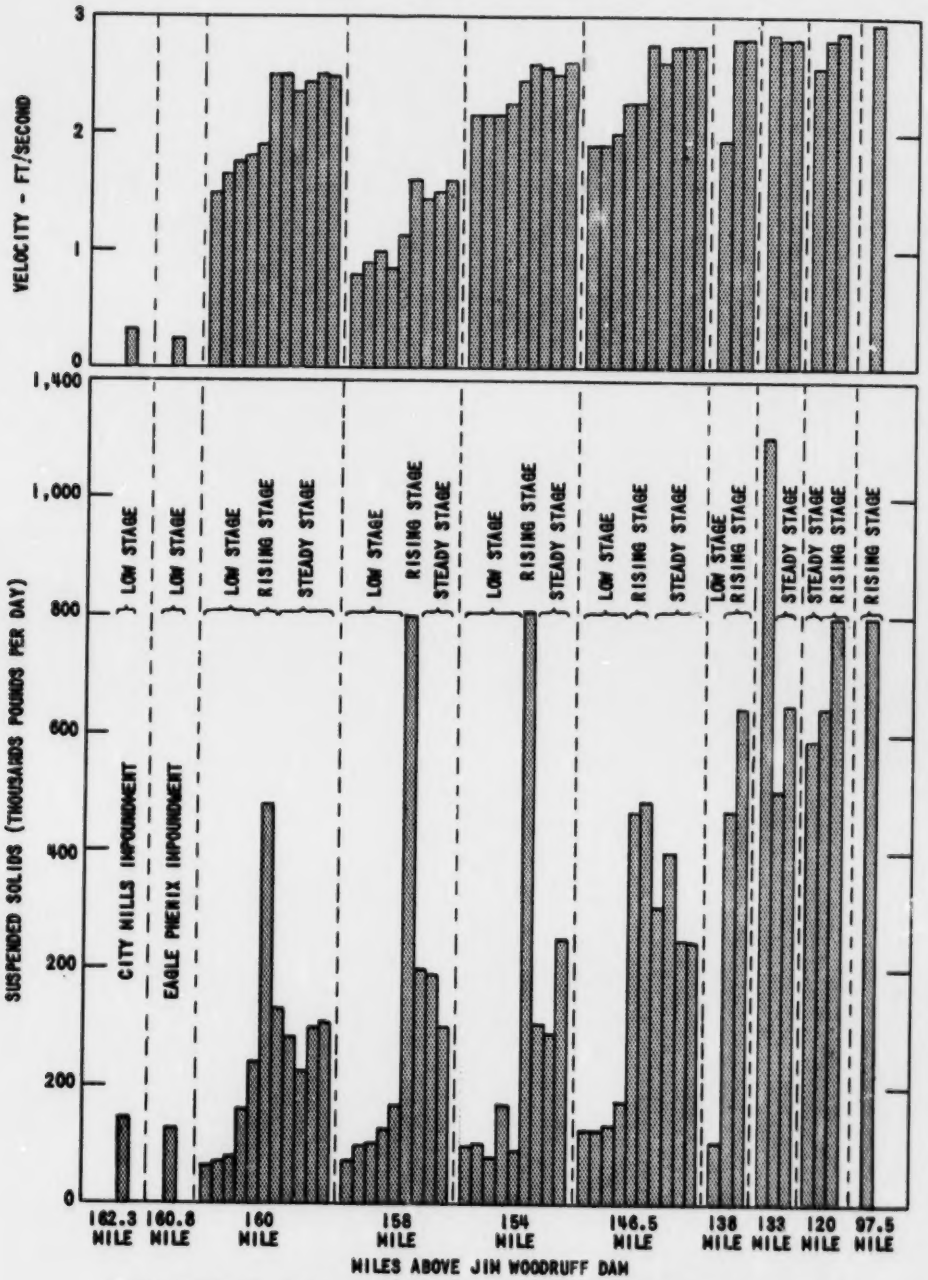
CHATTAHOOCHEE RIVER - WATER TEMPERATURES AND MEAN DAILY FLOWS DURING SURVEY

Figure 2



CHATTAHOOCHEE RIVER - TYPICAL VARIABILITY OF FLOW DURING LOW FLOW PERIOD OF SURVEY

Figure 3



CHATTAHOOCHEE RIVER - EFFECT OF VARIOUS RIVER STAGES ON SUSPENDED SOLIDS BELOW COLUMBUS IMPOUNDMENTS

Figure 4

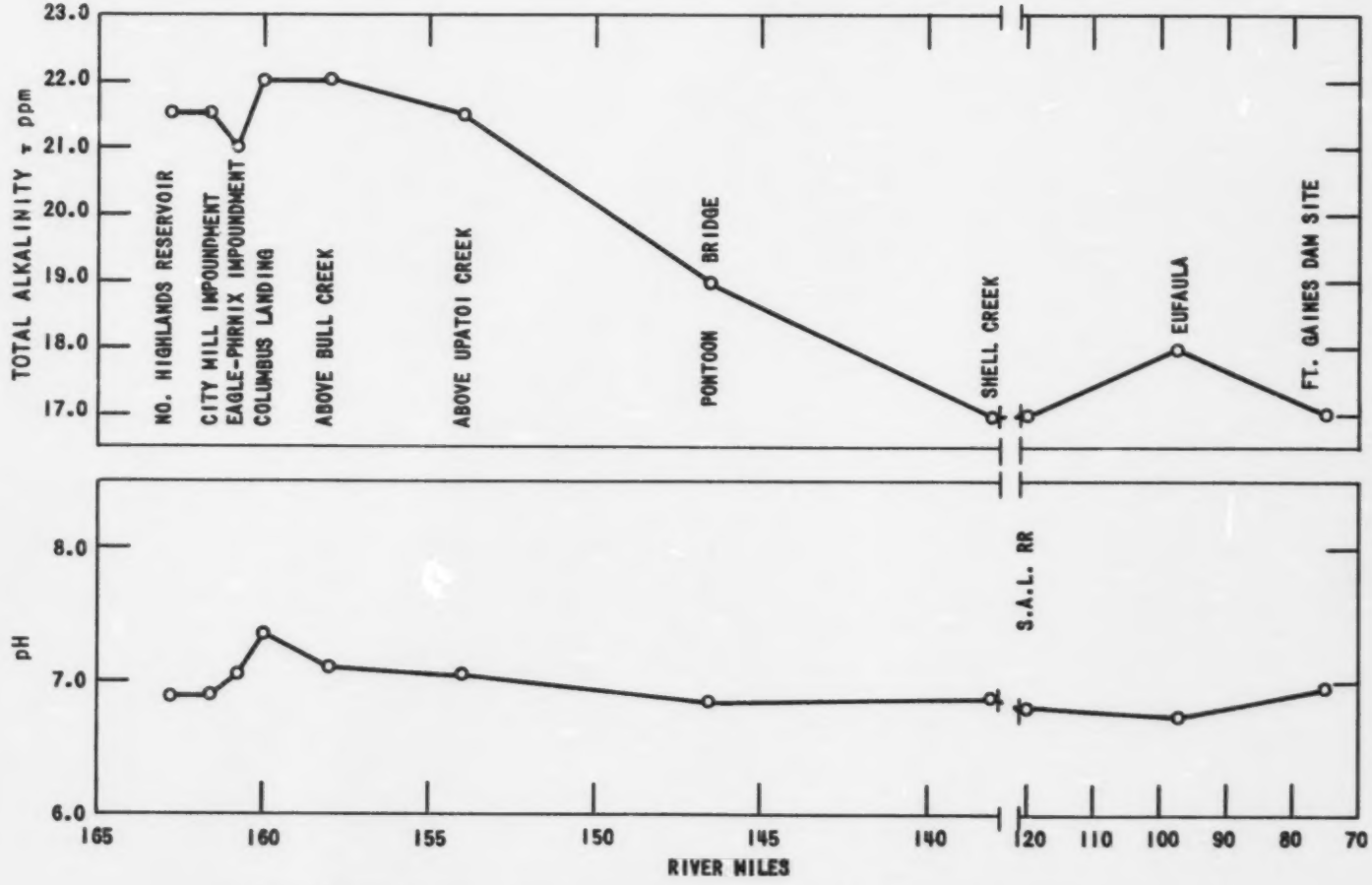
the magnitude of this action. (Also See Appendix II, Suspended Solids.) Note that the velocities given in Figure 4 are for respective downstream stations and that only relatively low flow velocities are given for the impoundments. Computed velocities upwards of 0.7 ft. per second would occur in the impoundments when in correspondence with the downstream peak velocities shown.

A natural sludge bed was observed near the mouth of Bull Creek. This creek received raw sewage from part of the South area. As shown later, the station downstream from Bull Creek reflected no detectable load from this creek. It is believed that at this time a large portion of this waste load was temporarily removed in the process of forming the sludge bed.

Chemical Factors

Alkalinity and pH

The alkalinity and hydrogen ion concentrations (pH) observed at various river miles are shown in Figure 5. (Also See Appendix II, pH and Total Alkalinity) It is noted that a slight increase in both alkalinity and pH occurs below the waste load sources of the Columbus and Phenix City area. This increase may be partially due to the highly alkaline nature of the textile mill waste discharges above. A gradual reduction in these values, as noted at downstream stations, indicates the dilution effect of tributary flow and production of carbon dioxide in the decomposition of the organic material.



CHATTAHOOCHEE RIVER - TOTAL ALKALINITY AND pH BY RIVER MILES DURING LOW FLOW

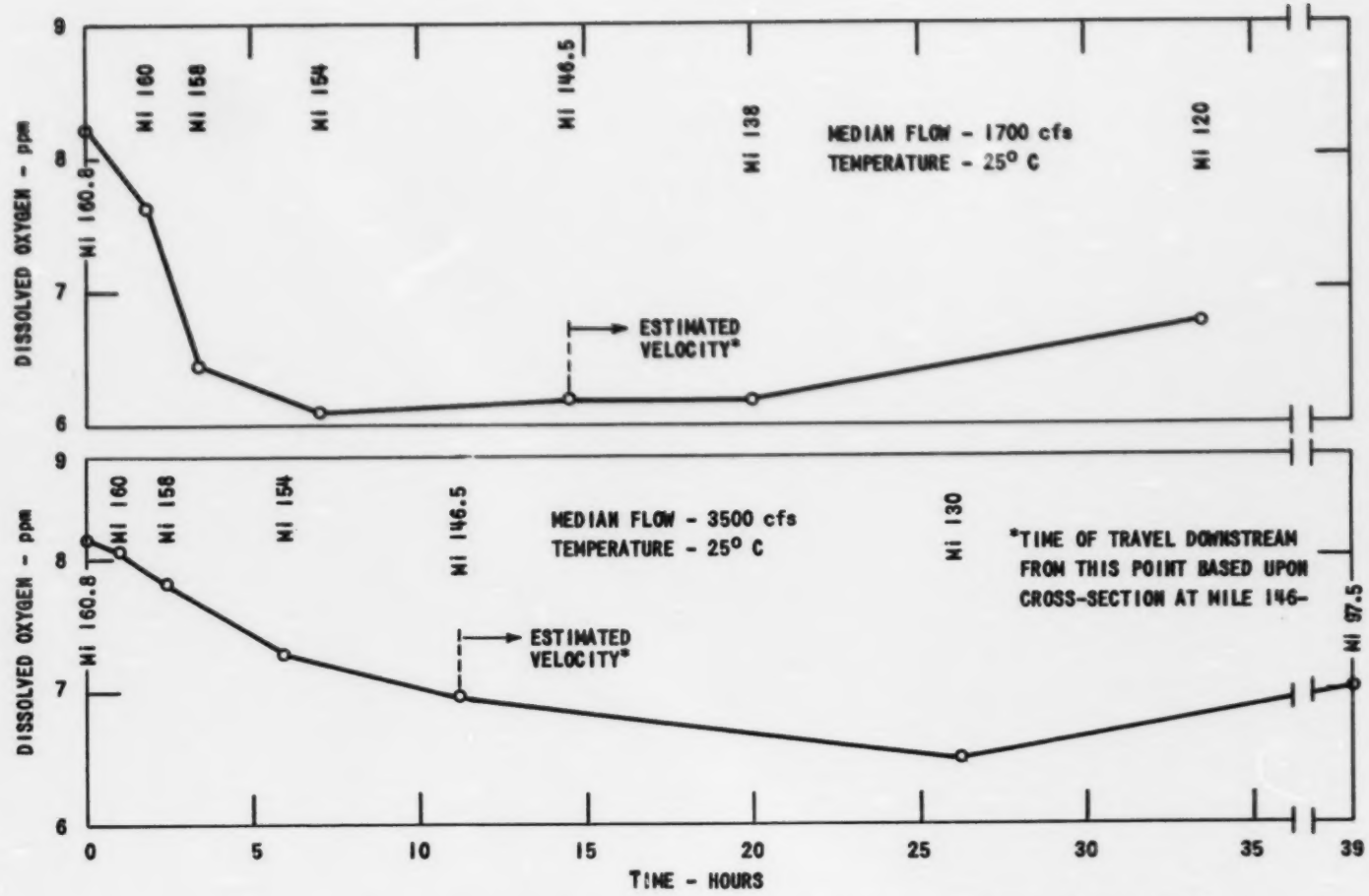
Figure 5

Dissolved Oxygen

As a result of the variations in flow during this survey it was possible to make comparisons of the effect of flow on the dissolved oxygen concentration. Since the temperatures also varied, for purposes of comparison, all dissolved oxygen values have been corrected to 25°C. Figures 6a and 6b show these comparisons. Only the low flow data were used to establish the purification criteria presented in a later section. It is noted that a rather rapid reduction in dissolved oxygen concentration takes place in the section of river immediately below the main source of pollution. Also of note is the slowness of recovery downstream. During relatively higher flows, the respective lowered dissolved oxygen condition is lengthened further downstream. The lowest dissolved oxygen concentration observed was 4.00 ppm at Mile 146.5 (pontoon bridge) early in the survey (see Appendix II, Dissolved Oxygen). The flow at this time was approximately 1,400 cfs and water temperature 28°C.

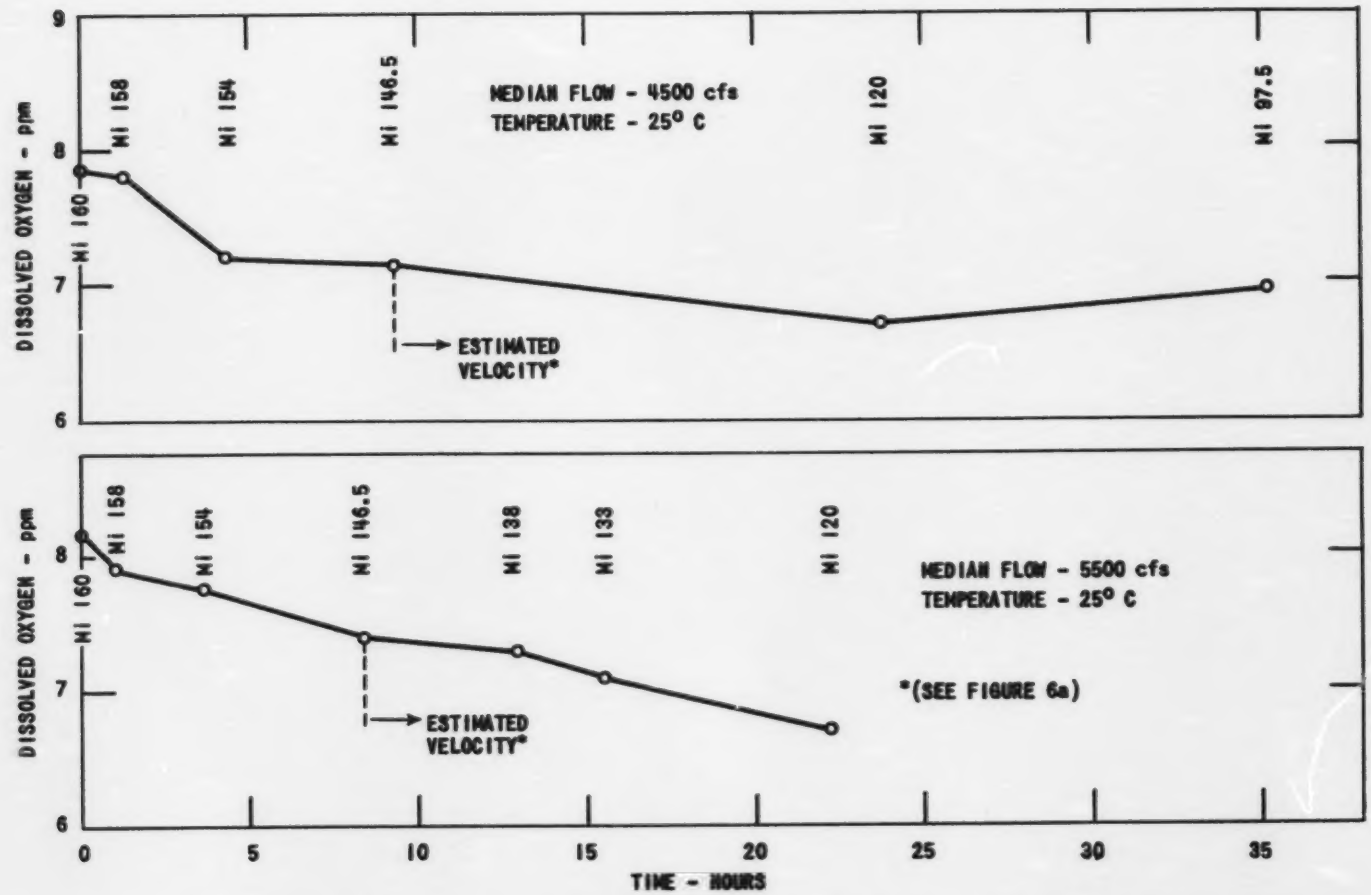
Biochemical Activity

The biochemical activity in the river was studied from the standpoint of the demand exerted by this activity on the dissolved oxygen content at various points along the river. A mathematical determentation of the rate of oxygen depletion exerted by the biochemical oxygen demand (BOD) is presented in a later section. Figures 7a and 7b show the BOD loading in terms of pounds of total carbonaceous BOD corresponding to various stations and time of travel downstream.



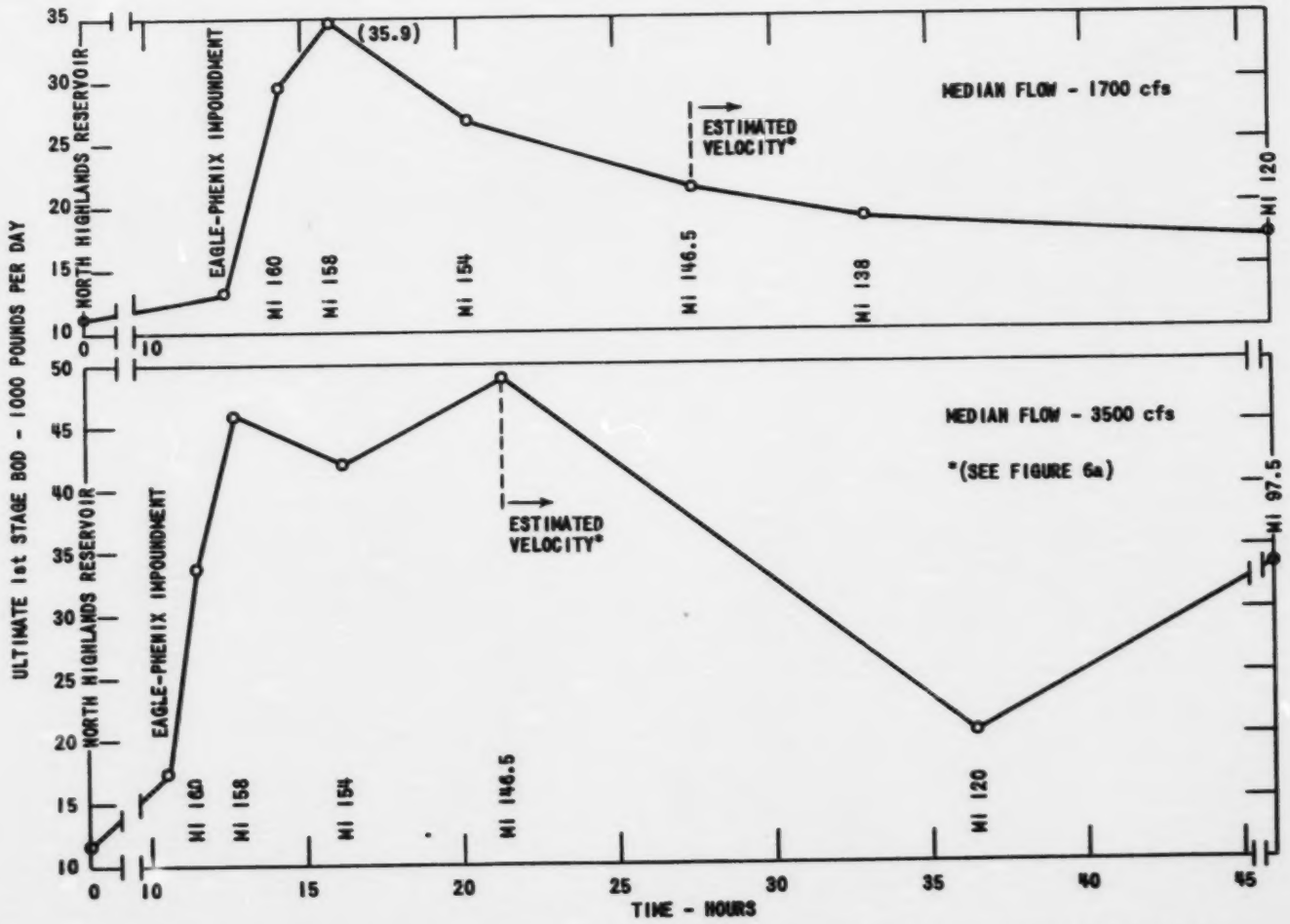
CHATTAHOOCHEE RIVER - OBSERVED DISSOLVED OXYGEN PROFILES CORRESPONDING TO FLOW AND TIME OF TRAVEL

Figure 6a



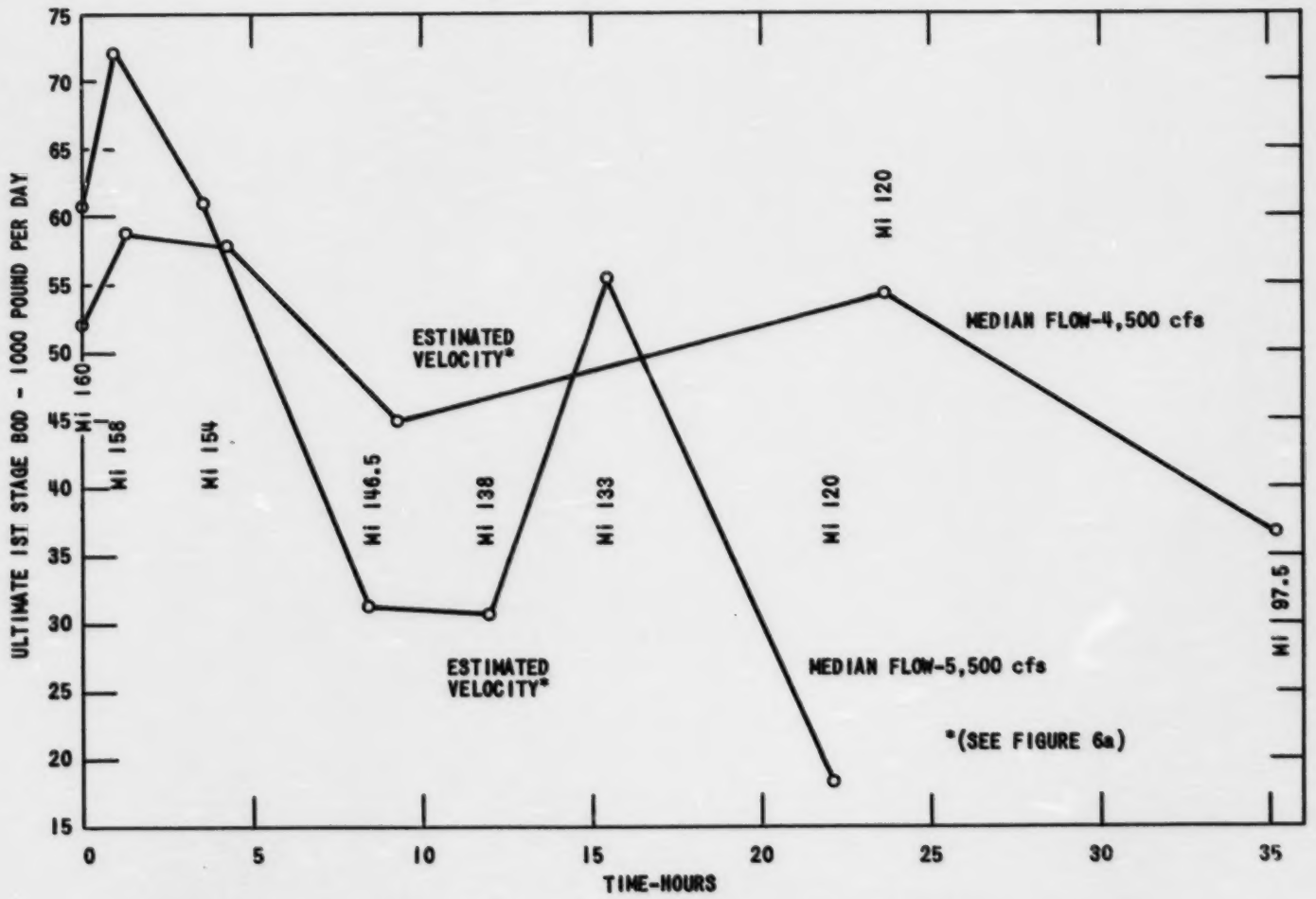
CHATTAHOOCHEE RIVER - OBSERVED DISSOLVED OXYGEN PROFILES CORRESPONDING TO FLOW AND TIME OF TRAVEL

Figure 6b



CHATTAHOOCHEE RIVER - BIOCHEMICAL OXYGEN DEMAND CORRESPONDING TO FLOW AND TIME OF TRAVEL

Figure 7a



CHATTAHOOCHEE RIVER - BIOCHEMICAL OXYGEN DEMAND CORRESPONDING TO FLOW AND TIME OF TRAVEL

Figure 7b

The values shown are averages of the BOD found at each station during relatively similar flows and are adjusted to the approximate median of those flows.

The BOD values do not necessarily constitute consecutive values found at the various stations downstream for any one given day. As an illustration of this: a flow of 2,000 cfs at the gauge station (Mile 160) does not necessarily mean that at Mile 120 the flow is 2,000 cfs. The actual flow at Mile 120 would have been that shown at the gauge some 30-35 hours earlier plus tributary flow. For this reason, the downstream flows shown are adjusted to respective gauge readings corresponding to time of river travel and tributary flow. By accumulating BOD values corresponding to flows of similar magnitude, a reasonable evaluation of the rates of BOD satisfaction based upon consistent time of travel through a given section of the river was possible. It is seen in Figures 7a and 7b that, as the flows increased, there was an increase in BOD (Also, see Appendix II, BOD Data). Flushing and scouring are again indicated.

The tributary flow adjustments, previously mentioned, were obtained by computing the appropriate fraction of total drainage area between the Columbus, Georgia, gauge and Columbia, Alabama, gauge (See Appendix II, Flow Data). By applying these fractions to the total gain in tributary flow between the two gauge stations each consecutive major tributary flow could be determined.

Biological Conditions

Biological conditions of the river water and river bottom were examined in the impoundments and downstream sections. Dredge hauls in the Eagle Phenix impoundment showed deposits of black organic color (weak sludge) mixed with fine sand, silt and mud. A slight sewage odor was detected. The hauls contained mainly sludge worms, fingernail clams and blue-green algae, which represent an organism-association tolerant of pollution. The City Mills impoundment revealed the presence of blue-green algae and bloodworms near one of the sewer outfalls, and deposits had a strong sewage odor. Floating solids were not observed. As an example of the effect upon deposition of settleable solids caused by the reduced velocity in this impoundment, an alluvial fan of sand, silt and clay some 100 feet across at maximum width was observed. This alluvial fan originated from a small stream entering the impoundment and extended out some 150 feet.

Dredge samples taken below the Columbus impoundments indicated no sludge deposits from Mile 160 through Mile 97.5. The hauls made were without sewage odor and could be classified as "earthy." All marginal bank and sand bar areas revealed no visual evidence of sludge deposits. Bottom animals were not found in any of the dredge hauls from this section. The sand and gravel bottom of the Chattahoochee River can be likened to a "ball" mill in the destruction

of animals, that might otherwise occur if composed of sludge and/or mud, as sediments are rolled over.

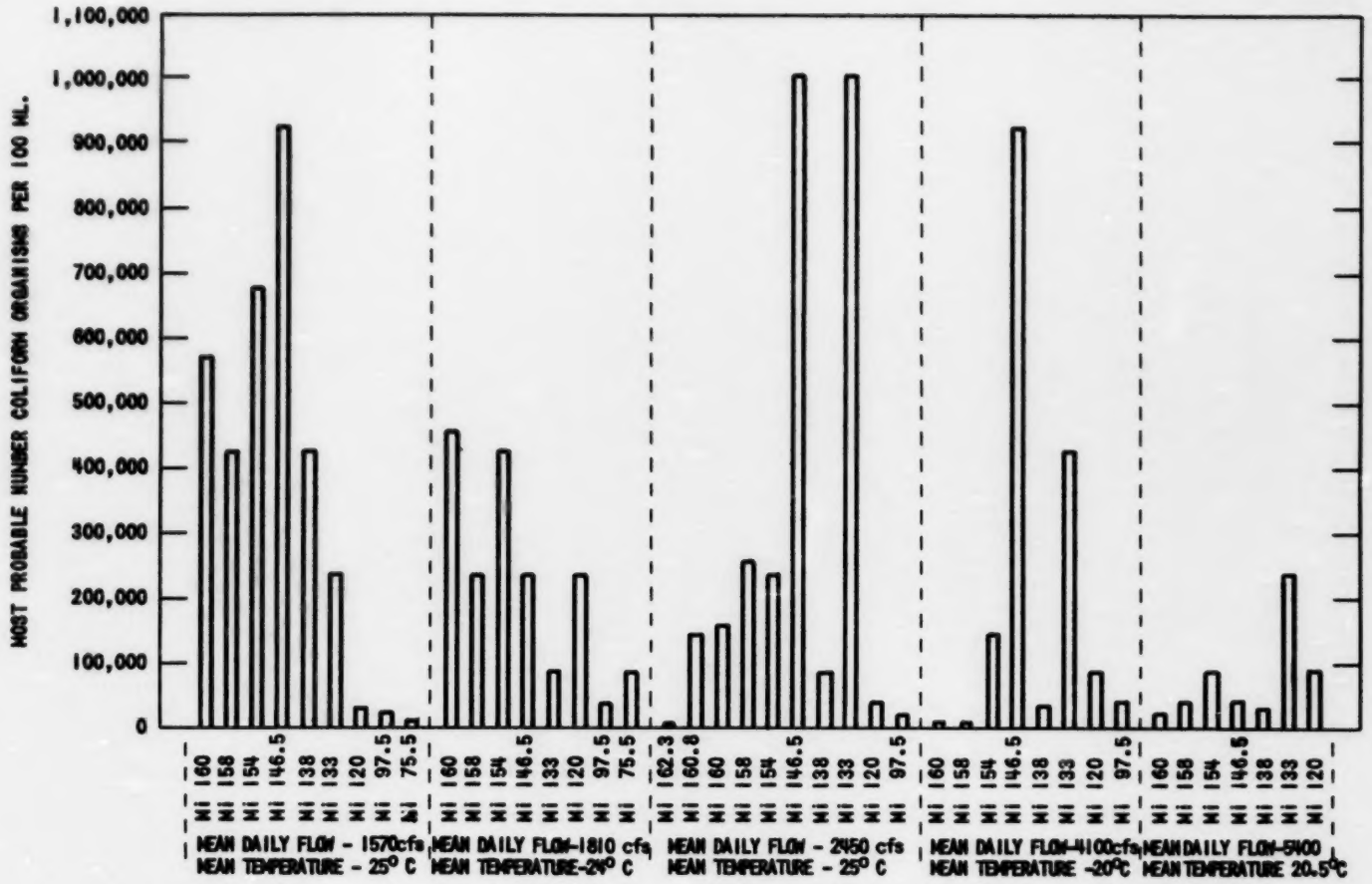
Plankton samples were collected in the impoundments and at 28 stations downstream to Mile 97.5. By casual examination plankton was less abundant from Mile 160 through Mile 154 than at stations farther downstream. Mixtures of silt with plankton became especially obvious at Mile 138 and continued through Mile 97.5. Samples of plankton taken from the Goat Rock Reservoir* contained the least abundance of plankton of all collections on the Chattahoochee. Plankton taken from the North Highlands impoundment contained an amount comparable to that collected at Mile 160, and the plankton from the Eagle Phenix impoundment was comparable in volume between that found in the Goat Rock Reservoir and North Highlands Reservoir.

Bacteriological Examination

The magnitude of coliform organisms originating from sewage discharges is shown in Figures 8 and 8a (Also see Appendix II, Bacteriological Data).

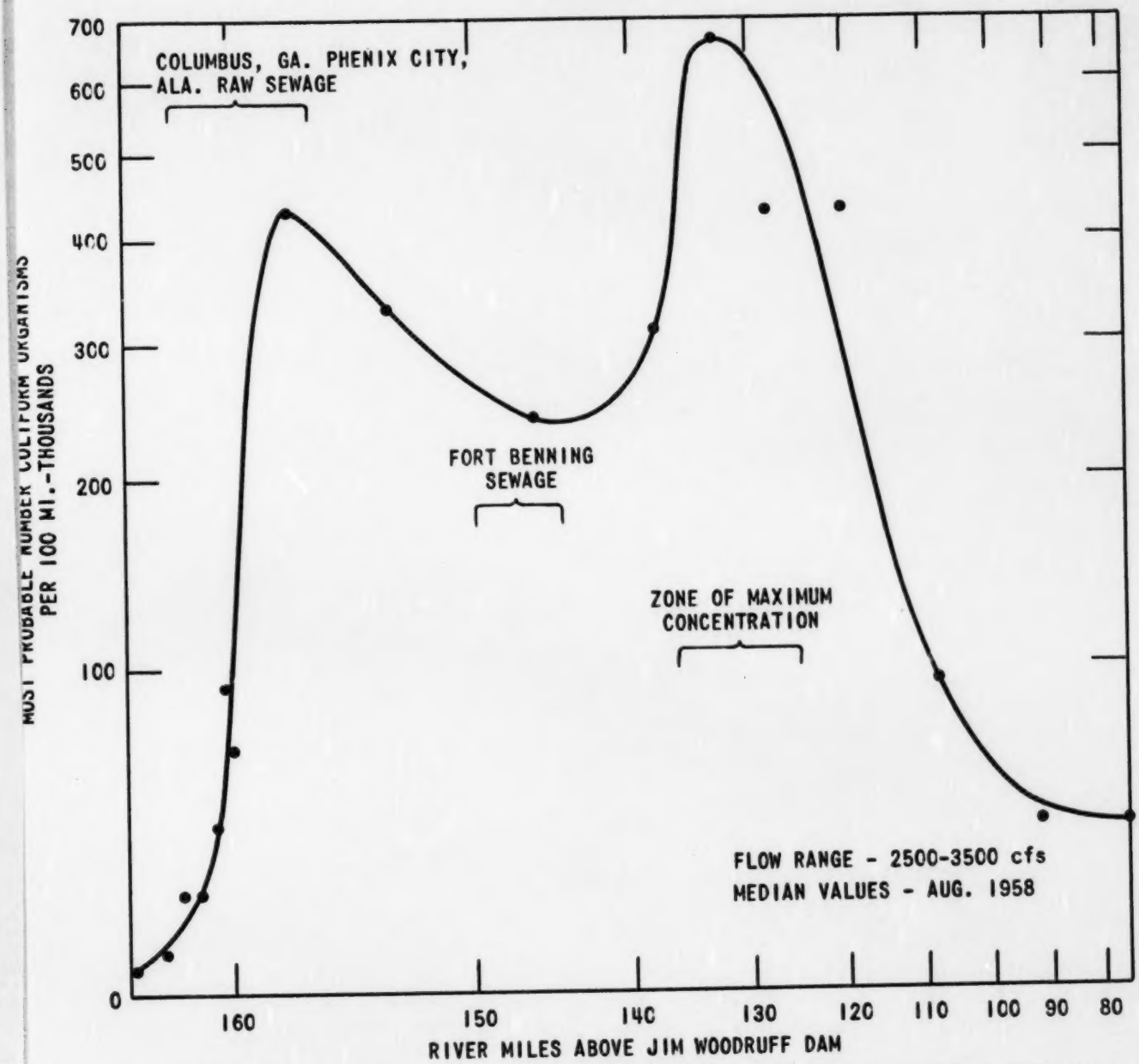
The effect of fluctuating flows encountered in 1957 on coliform concentrations is exhibited in Figure 8. At relatively low flow the increase and subsequent die-off of the organisms is best demonstrated. The graphical representation of median coliform concentrations shown In Figure 8a is typical of the magnitude of coliform organisms

* Located upriver from North Highlands impoundment.



CHATTAHOOCHEE RIVER - COLIFORM DENSITY BY RIVER MILES AND CORRESPONDING MEAN DAILY FLOW

Figure 8



CHATTAHOOCHEE RIVER - COLIFORM ORGANISMS, COLUMBUS TO FORT GAINES, GEORGIA SHOWING EFFECT OF RAW SEWAGE DISCHARGES AND RATE OF COLIFORM INCREASE AND DIE-OFF

Figure 8a

existing between Columbus and Fort Gaines during relatively stable flow conditions and demonstrates the increase and die-off trend associated with sewage discharges and distances traveled downstream. In general, the pattern of coliform populations observed at the various river miles is indicative of the stepwise introduction of sewage to the river. The increase in coliform concentrations noted at Mile 133 demonstrates the increase to a zone of maximum concentration which is often observed below sources of heavy sewage pollution.

Sewer Studies

Columbus area

As stated earlier, there are twenty-two combined sewer outfalls discharging domestic wastes to the Chattahoochee River from the Columbus area. Seven of these sewers carry the major sewage loads and discharge to the river below the impounded section. The average daily pollution loads expressed as equivalent populations being discharged from each of these seven sewers are shown below. (Also see Appendix III, Analysis of outfall wastes and waste effluents.)

SEWER OUTFALL, PHENIX CITY, ALABAMA, DISCHARGING TO HOLLAND CREEK AND
TO THE CHATTAHOOCHEE RIVER IMMEDIATELY BELOW THE EAGLE PHENIX DAM
ILLUSTRATION 5

Major Columbus Sewers and Pollution Loads Discharged

Sewer Outfall Location*	Population Equivalent
12th Street	3,000
11th Street	10,500
9th Street	5,000
7th Street	30,000
5th Avenue	** 52,500
Into Bull Creek	6,500
*** Below Bull Creek	11,500
Total	119,000

* Point of discharge to Chattahoochee River.

** Includes industrial waste PE of 9,500.

*** New interceptor constructed by Muscogee County serving South Area and part of Bull Creek Area.

The City of Columbus is essentially one hundred per cent sewered, and, according to the results of the sewer studies, approximately ninety per cent of this sewage load is discharged below the impounded section of the Chattahoochee River. Since it is estimated that approximately 26,000 people reside in the section of Muscogee County south and east of Columbus city limits, it appears that about seventy per cent of the population in this area is sewered. This is part of the area to be annexed by the city of Columbus in 1959.

Phenix City

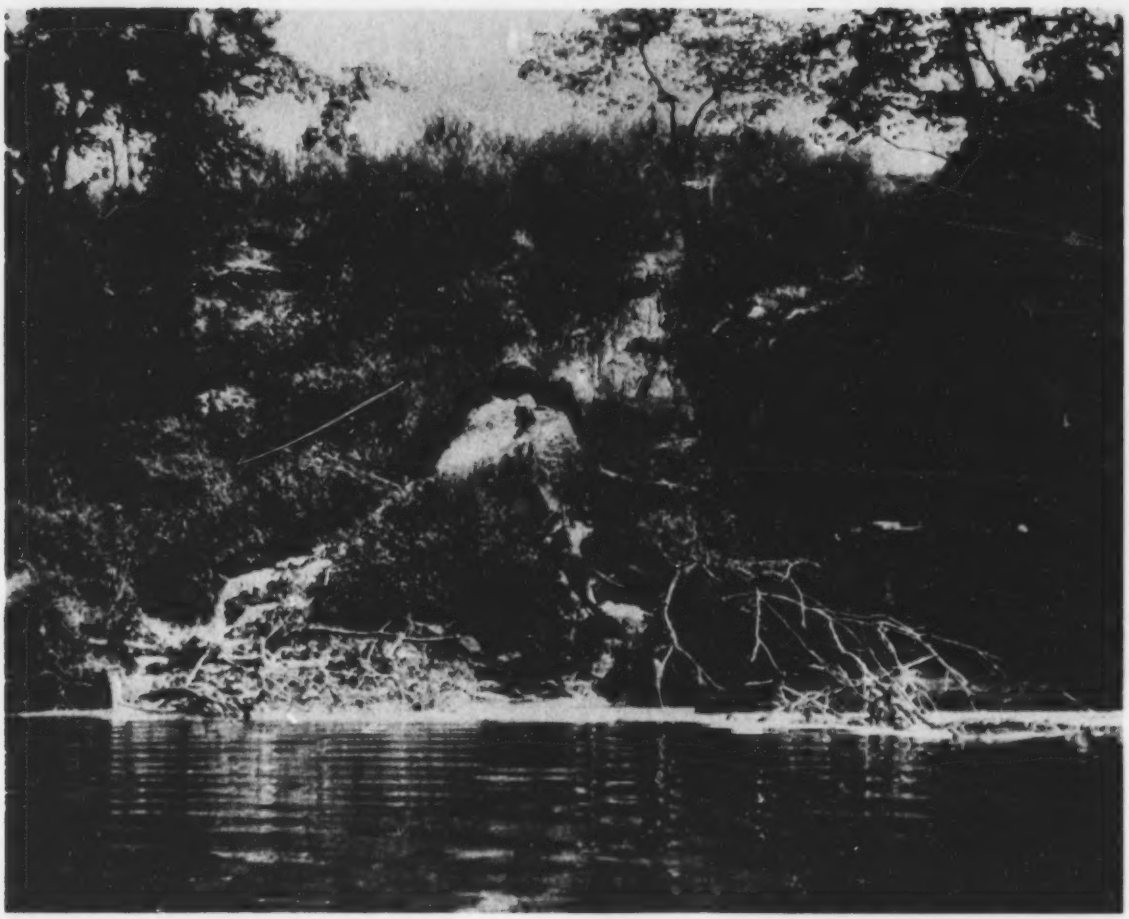
All of the sewage outfalls discharging to the Chattahoochee River from Phenix City were investigated. The average daily population loads discharged from each of nine outfalls studied are shown below. (Also see Appendix III, Analysis of outfall wastes and waste effluents.)

Phenix City Sewers and Pollution Loads Discharged

Sewer Outfall Location*	Population Equivalent
29th Street	250
25th Street	250
18th Street	4,700
16th Street	3,400
15th Street	200
N. Holland Creek	5,500
Into Holland Creek	2,500
Dillingham Street	2,200
Total	19,000

* Point of discharge to the Chattahoochee River.

Since the 1958 population of Phenix City is estimated to be 28,000, it is concluded from the sewer studies that about 70 per cent of this population is now sewered. The results also show that



SEWER OUTFALL, MUSCOGEE COUNTY, DISCHARGING TO THE CHATTAHOOCHEE RIVER
IMMEDIATELY DOWNSTREAM FROM BULL CREEK

ILLUSTRATION 6

approximately 55 per cent of the sewered population is discharged to the Chattahoochee River below the impounded section.

Eufaula, Alabama

The population equivalent of sewage discharged to the Chattahoochee River at Eufaula, Alabama, was found to be approximately 4,000. The present estimated total population at Eufaula is 7,000. Therefore, it is estimated that 55 to 60 per cent of the population of Eufaula, Alabama, is connected to sewers. (See Appendix III, Analysis of outfall wastes and waste effluents.)

Industrial Waste

Studies were made of industrial waste effluents being discharged directly into the Chattahoochee River in the Columbus area. Results show an addition of BOD to the river amounting to a population equivalent of approximately 30,000. (See Appendix III, Textile Mill Waste.) Essentially no insoluble solids were contained in these effluents. However, results show that approximately 6,000 pounds of dissolved solids are discharged from this source per day.

RIVER DATA ANALYSIS

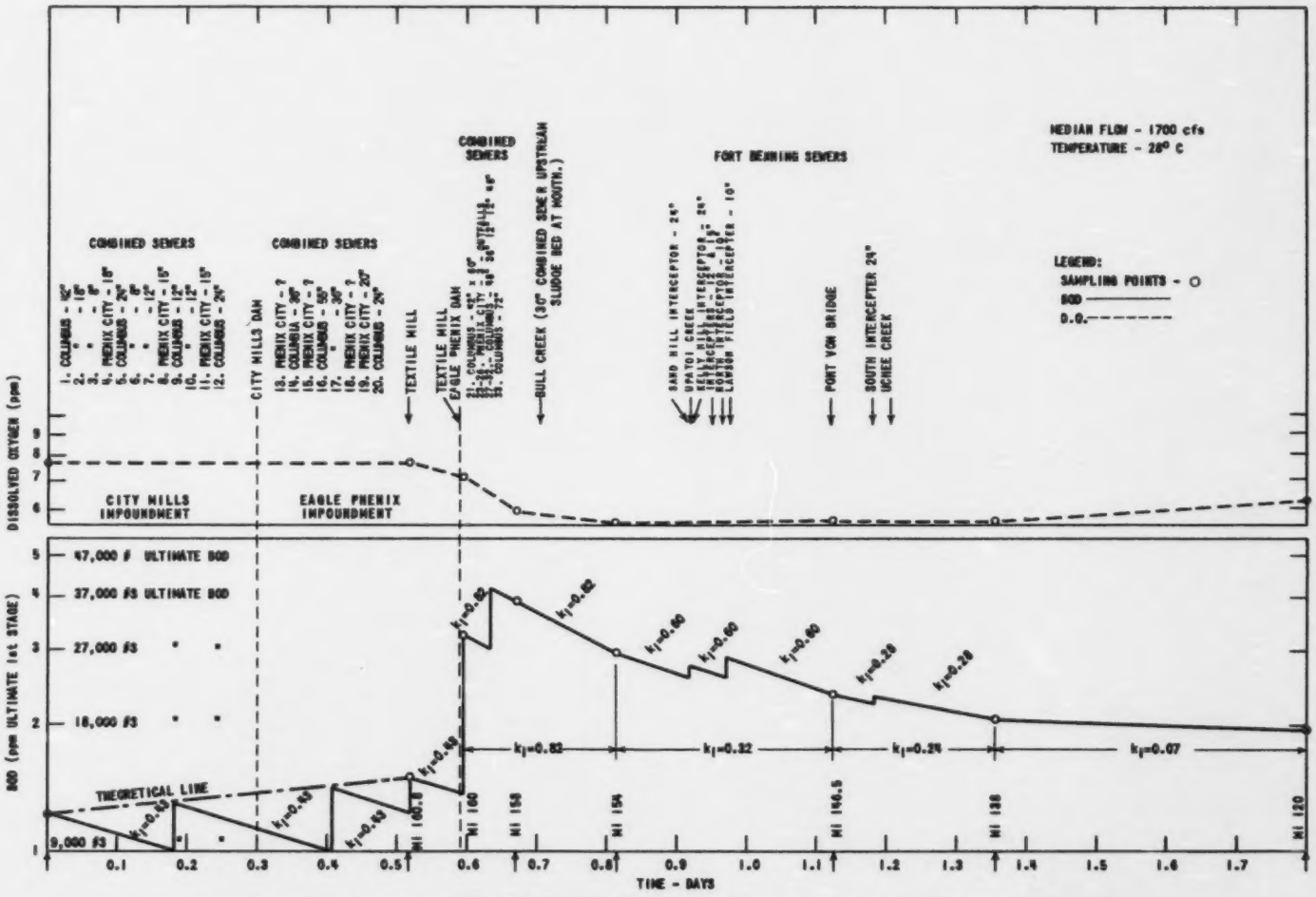
Deoxygenation Velocity Constants

The biochemical oxygen demand data have been shown in Figures 7a - 7b. Only those data obtained during the lowest flows (Median 1,700 cfs) are used in calculating deoxygenation velocity constants for the section of the Chattahoochee River under investigation. The methods of determining and adjusting flows at respective downstream stations were explained in the section on Biochemical Activity. Time of river travel used in the calculation was obtained from cross-section measurements and velocity - discharge curves.

It should be noted that all the river BOD concentrations are given as ultimate first stage (carbonaceous) values. The ultimate values serve as a better means of BOD comparison and are necessary in the determination of deoxygenation velocity constants. Calculations show that the deoxygenation velocity constant (k_1) differed between the various sections under examination. (See Appendix IV, Deoxygenation Velocity Constants)

Assimilation of BOD Loads

A graphical representation of the BOD loading and assimilation of these loads during time of travel downstream is shown in Figure 9. In order to compute the amount of BOD satisfaction between points of pollution loads, the deoxygenation velocity constants (k_1) were averaged



CHATTAHOOCHEE RIVER, GA. - GRAPHICAL REPRESENTATION OF LOAD PATTERN AND ASSIMILATION OBTAINED FROM RIVER DATA

SURVEY SEPT. - OCT. 1957

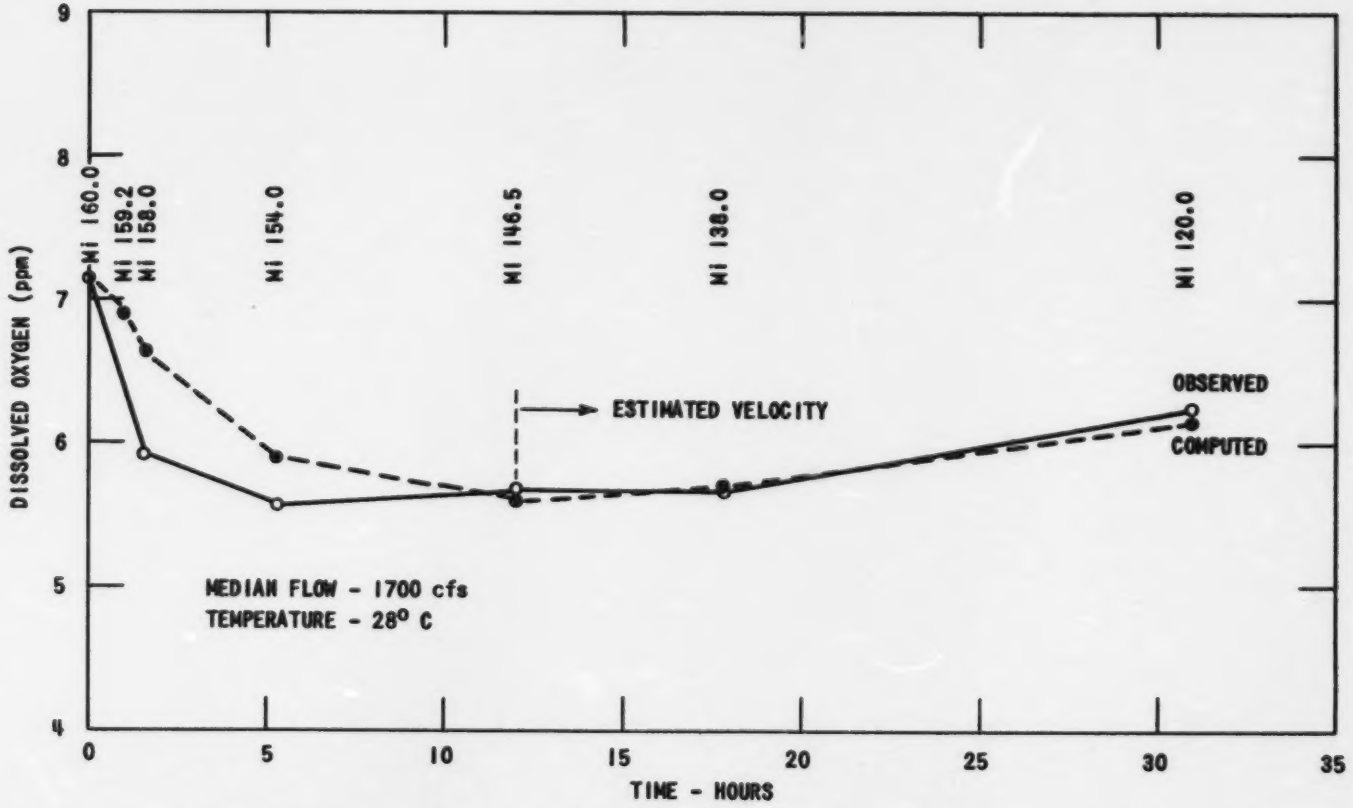
Figure 9

for each consecutive section and slopes projected at the various sources of pollution to represent the loads introduced.

The data show that the initial BOD contained in the river (or an equivalent amount) as it enters the Columbus and Phenix City area is satisfied within the impoundments. These data also show an addition to the river of BOD load equivalent to 100,000 population by the time Mile 158 is reached. No appreciable quantity of BOD originating from Bull Creek is noted from these data. It is believed that the sludge bed found near the confluence of this stream (flow approximately 15 cfs at this time) caused a high degree of apparent BOD satisfaction before discharge to the Chattahoochee River. Had this not occurred, an additional population load of approximately 20,000 would be added to the river at Bull Creek as determined from the study of the Bull Creek and Muscogee County sewers. The data show also that, as the Chattahoochee River passes through the Fort Benning Reservation, an additional BOD load equivalent to 24,000 population is introduced. The population equivalents calculated from river BOD data tend to be somewhat lower than estimated sewered populations because of the rapidity with which BOD in the river is reduced.

Reaeration Velocity Constant and
Computed Dissolved Oxygen Sag Curve

A reaeration velocity constant (k_2) of 0.45 has been found for the stretch of river under examination. This value, when applied to



CHATTAHOOCHEE RIVER - DISSOLVED OXYGEN PROFILE - OBSERVED VERSUS COMPUTED

Figure 10

the conventional dissolved oxygen sag equation developed by Streeter and Phelps,(2) results in a similarity to the dissolved oxygen deficits observed during the survey. Figure 10 shows the dissolved oxygen profile as it was observed compared to the computed profile.

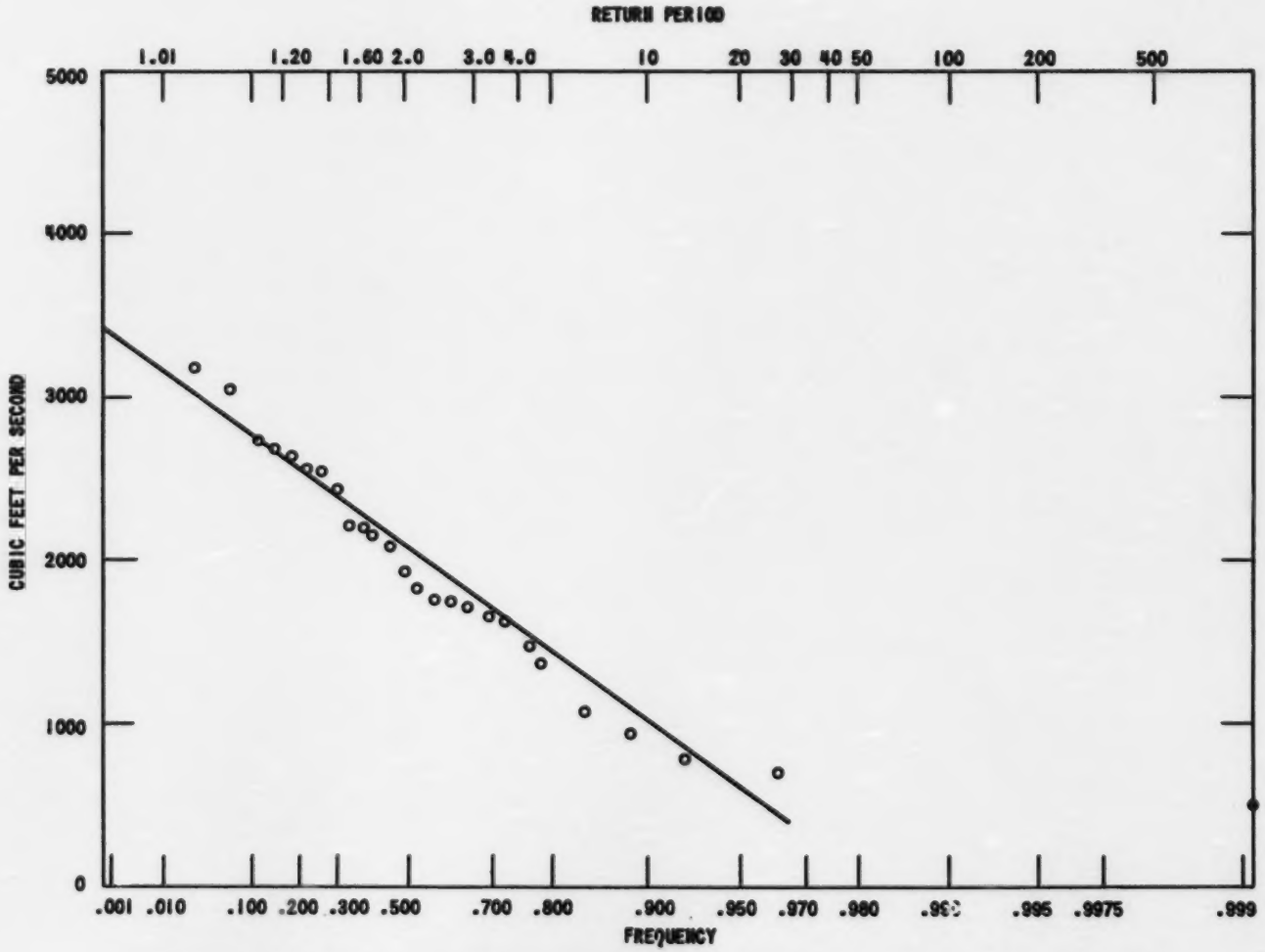
It is noted that the observed dissolved oxygen concentration drops off at a greater rate than those computed. Indications are that the deoxygenation velocity constant (k_1) for this section of river is perhaps greater than 0.82.* This relatively high rate may be attributed to readily decomposable materials contained in the soluble portion of the industrial waste described previously and/or to highly acclimated and active organisms originating from the impoundments above this section of the river, and partially to limited deposition in areas where velocity is checked by piling.

Calculated Dissolved Oxygen Profiles Resulting
from Collection and Point Discharge of
Untreated and Treated Sewage During Sustained
Low Flow Periods

Present Pollution Loads

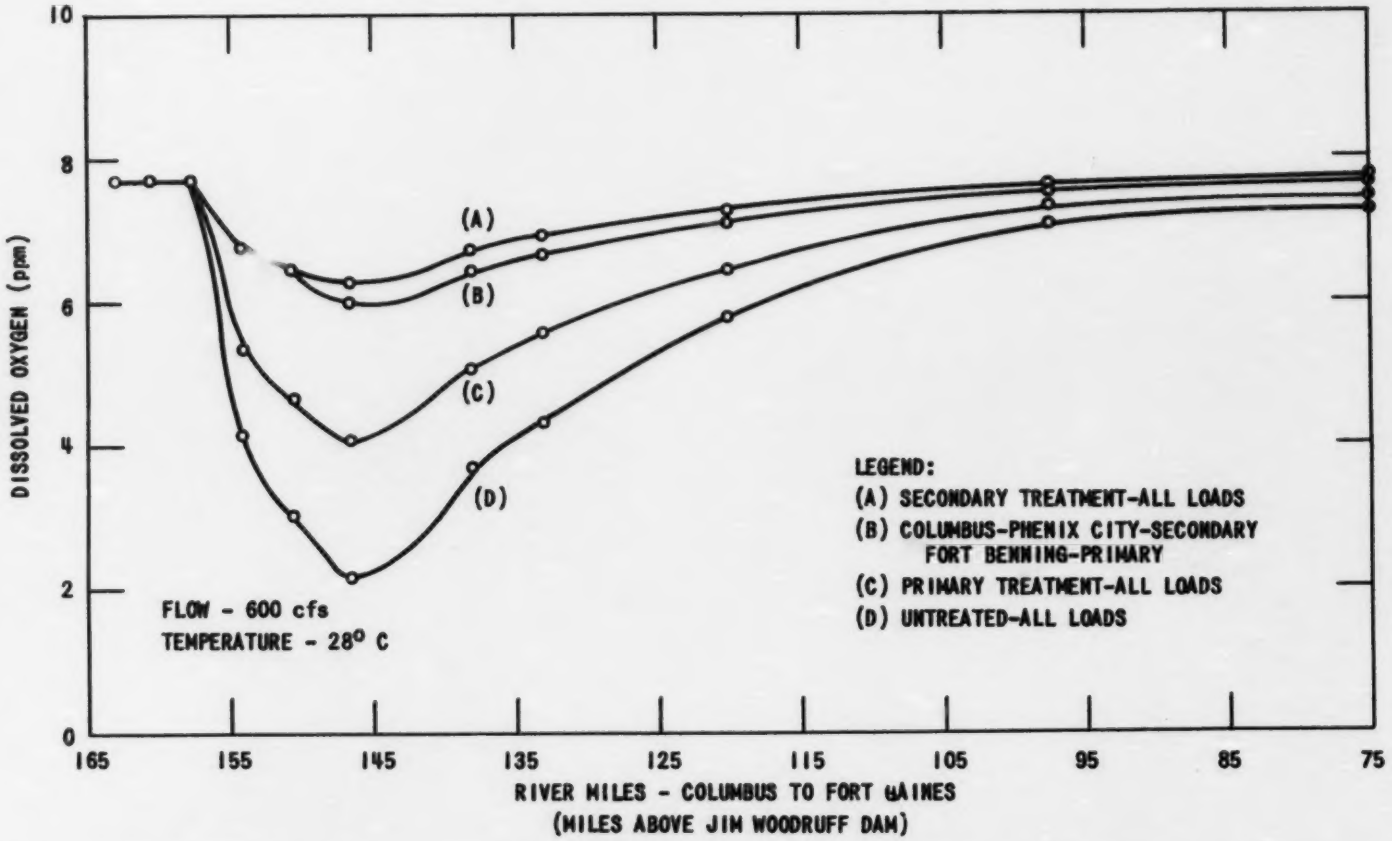
From 25 years of flow records on the Chattahoochee River it has been determined that a minimum monthly flow of 1,000 cfs will occur once in ten years and that a minimum monthly flow of 600 cfs will occur once in 20 years. (See Figure 11.)

* The 1958 survey confirmed that a slightly higher (k_1) exists.



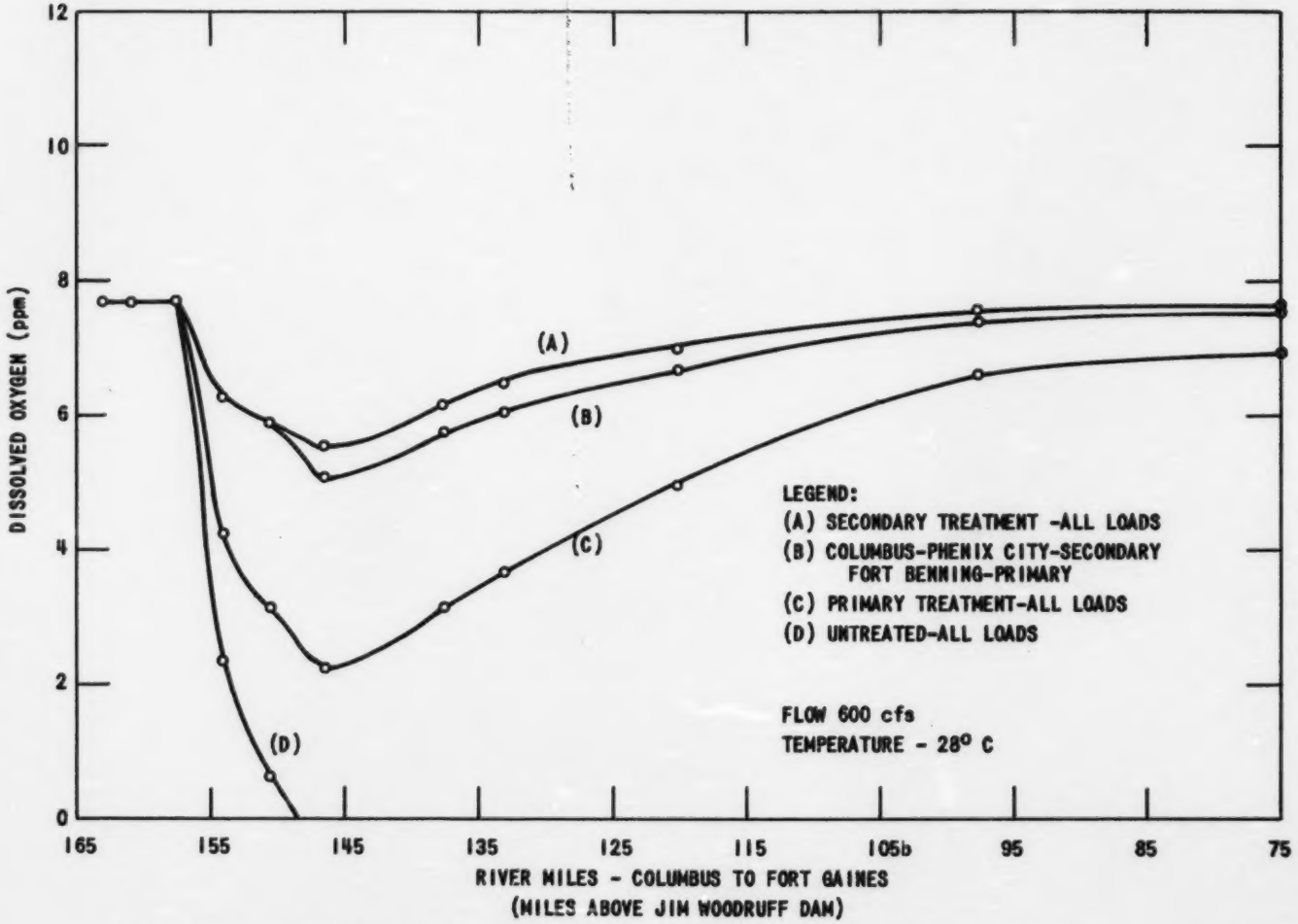
CHATTAHOOCHEE RIVER - COLUMBUS GA. MEAN MONTHLY - 25 YEARS - MEAN MINIMUM (1931-1956)

Figure 11



CHATTAHOOCHEE RIVER - DISSOLVED OXYGEN PROFILE - WASTE COLLECTION AND POINT DISCHARGE
FREE FLOWING RIVER (PRESENT POPULATION LOADS)

Figure 12



CHATTAHOOCHEE RIVER - DISSOLVED OXYGEN PROFILE - WASTE COLLECTION AND POINT DISCHARGE
FREE FLOWING RIVER (1977 POPULATIONS)

Figure 13

For purposes of calculating the effect of collection and point discharge of all waste loads, the 20 year minimum monthly flow of 600 cfs is used. Discharges from Phenix City and Columbus are assumed to be made at Mile 157 (Bull Creek) and those from Fort Benning, at Mile 150.5 (Upatoi Creek). The computed dissolved oxygen profiles for collection and point discharge of sewage from these areas based upon present sewered populations (165,000) are shown in Figure 12. A population load of 30,000 added from the Fort Benning Military Reservation is assumed. Consideration is made in the calculations of the industrial waste discharged above the points of sewage discharge. Based upon the rate of satisfaction of loads in the impoundments, approximately half of the industrial loads would exist in the river by the time introduction of sewage was made at Mile 157. An adjustment in the reaeration velocity constant (k_2) was made for the dissolved oxygen profile calculations at 600 cfs. With a reduction in depth and velocity there is an increase in the rate of reaeration.(3) A reaeration velocity constant (k_2) of 0.60 was used in making these calculations.

Future Pollution Loads

The dissolved oxygen profile under conditions, as above, using the 1977 predicted population for the Columbus and Phenix City area, is shown in Figure 13. The predicted North Columbus population has been omitted from these calculations, since it is indicated that this

load would be treated separately. No allowance is made for future increases in industrial loads. A Fort Benning population of 50,000 is used.

DISCUSSION

Water Pollution and Sanitation

The major uses made of the Chattahoochee River from Sargent, Georgia, to approximately Columbia, Alabama, are for production of power, source of municipal and industrial water supplies, and for disposal of domestic sewage and industrial waste. Except for limited use for fishing and boating the Chattahoochee River from Columbus, Georgia, to the Fort Gaines Dam site is used exclusively for the disposal of domestic sewage and industrial waste.

The section of the Chattahoochee River from Sargent, Georgia, to the Jim Woodruff Dam, a distance of 250 river miles, receives sewage and industrial wastes equivalent to one third of a million people or an average of over one thousand people per mile. Fortunately, the river has the ability to reduce some of this waste load it receives by a process of natural biochemical degradation and physical sedimentation.

As the Chattahoochee River enters the Columbus and Phenix City area it contains a biochemical oxygen demand population equivalent (PE)* of 40 thousand to 60 thousand and a bacterial (coliform) population equivalent (BPE)** ranging from approximately fifty to four thousand.

* PE = Ultimate carbonaceous BOD (pounds) ÷ 0.25 (per capita BOD)

** BPE = Q(cfs) X MPN (per 100 ml.) X (6.1×10^{-5})

The concentrations of coliform organisms found in the Chattahoochee River immediately above Columbus and Phenix City appear to be sufficiently low as to be within the water quality group recommended as suitable for public water supplies requiring complete rapid-sand filtration, or its equivalent, together with continuous post chlorination.(4)

At Columbus and Phenix City the detention time provided by the three impoundments, together with fresh waste loads to the river and aided by reaeration as the water falls over the dams, results in an increased rate of biochemical oxidation or organic degradation. The degradation rate and detention time during relatively low flow are sufficient to remove the oxygen demand exerted by waste loads equivalent to those entering the impounded section from up-river sources. The recovery in dissolved oxygen concentration to 85 - 90 per cent of saturation below the impounded section is attributed to aeration supplied by the Eagle Phenix Dam and rapids located below.

Aside from the localized pollution and unsanitary conditions existing along the edges and down the banks of the river below various sewage outfalls at Columbus and Phenix City, the effect of compounded sewage and industrial waste loads along the river is not obvious until Mile 158 is reached. Located in this vicinity are the ball park, fair grounds, football stadium and municipal golf course. Sewage odors are especially apparent in this area and are

noticeable at the motels and eating places paralleling the river below this point for approximately two miles. It is along this section of the river that much fishing is done. The river velocity near the shore is checked significantly by piling, causing a deposition of sewage solids. It was noted that sludge banks formed quickly and released gas to the atmosphere even during relatively short periods of low flow. Under prolonged low flows, in hot weather, nuisance odors are produced by these deposits. This was confirmed by employees of the nearby golf course. The river in this section becomes increasingly discolored by sewage and textile dye wastes. Floating material, films of oil and accumulations of scum occur along the edges and in various slow moving sections in this area. A sharp increase in coliform organisms and biochemical oxygen demand occurs in this section also. Concurrently, the dissolved oxygen content of the river water reduces noticeably and continues to do so for many miles downstream.

Further compounding of waste loads takes place at Bull Creek where two more sewers discharge to the river. One of these sewers discharges by way of Bull Creek and the other (Muscogee County sewer) discharges directly to the river below Bull Creek.

Bull Creek enters the Chattahoochee River at Mile 157. The total waste load equivalent of 186,000 people from Columbus, Phenix City and Muscogee County south and east of Columbus is discharged within this reach of the river, a distance of approximately

five river miles. However, river samples collected at this point do not reveal a waste load of this magnitude. The rapid rate of degradation, as before mentioned, continues to exert its effect down river from the impounded section, and, as waste loads are introduced, the BOD of each begins to immediately reduce. Figure 9 shows the effect of this action on incoming pollution loads. The increased rate (k_1) existing below the Eagle Phenix Dam is believed to be caused by the readily available carbohydrate substances included in the textile mill waste discharged above. The decline in rate further down river appears to be associated with the exhaustion of this carbohydrate material to a less readily decomposable substance remaining. The rates, as found from 1957 river data, were confirmed during 1958 by use of short term BOD tests in which a series of hourly BOD analyses were made under controlled conditions in the laboratory. (See Appendix IV, Deoxygenation velocity constants.)

The additional waste loads (population 30,000 - 35,000) entering the Chattahoochee River from the Fort Benning Military Reservation exert further reduction in dissolved oxygen and cause increases in coliform concentrations. The maximum effect of BOD on dissolved oxygen in the river during low flow occurs at approximately the Fort Benning pontoon bridge, or Mile 146.5 (See Figure 10). Although the Fort Benning sewage load is much smaller than that of the combined Columbus and Phenix City load, its effect in lowering the dissolved oxygen content is of significance.

Under critically low flow conditions a distance of fifty miles of river travel is required before recovery to the initial dissolved oxygen level is attained.

Virtually sixty-five miles of the Chattahoochee River are adversely affected by the BOD of sewage and industrial wastes discharged at Columbus, Phenix City and the Fort Benning Military Reservation. The entire eighty-five miles to Fort Gaines is contaminated by sewage bacteria. (See Figure 8 and 8a, Coliform organisms.) The quality of Chattahoochee River water from this section is considered unsuitable as a source of public water supply unless brought into conformance with requirements of water quality groups I, II, III or IV by means of prolonged preliminary storage or some other measure of equal permanent reliability.(4)

The sewage load of approximately 4,000 people added at Eufaula, Alabama, (Mile 97.5) does not amount to an appreciable increase in BOD but does increase bacterial contamination. A bacterial population equivalent of approximately 10 thousand was observed at the Fort Gaines Dam site at less than normal river stage. At higher stages the BPE would be expected to increase due to a shorter time of travel from the sources of sewage discharge making conceivable the possibility of bacterial contamination of oyster beds at Apalachicola Bay.

Corrective Measures

Present Pollution

In order to eliminate river contamination and unsanitary conditions existing in the Columbus and Phenix City area, it would be necessary to collect all sewage by means of central trunk interceptors which would discharge to the Chattahoochee River below the respective populated areas. Assuming it feasible to discharge all raw sewage loads to the river in the vicinity of Bull Creek, it can be shown that there would be times of extremely gross pollution down river. Bacterial contamination would undoubtedly be even greater than that which now exists, and the oxygen demand exerted by this heavy concentration of waste would reduce the dissolved oxygen content of the river to an extremely low level. The aquatic life and biological balance in the river would be altered and a nuisance odor condition could be created by putrefaction in quiescent pool areas. The extent of oxygen depletion and distance of the river affected is shown in Figure 12, (D). Generally, the minimum dissolved oxygen objective is 4-5 parts per million. This objective would not be met under these conditions. Greater pollution loads, equivalent to those predicted for the Columbus and Phenix City area, would completely deplete the oxygen in the river below the point of discharge at Bull Creek. (See Figure 13, (D).) Since the pollution loads of 1977 result in such extreme damage, it is apparent that a nearly septic condition could also occur from lesser loads before that time, when flows become critically low.

In order to prevent the conditions as stated above from occurring and to improve the quality and general sanitation of the lower Chattahoochee River Basin, it appears that treatment of wastes at Columbus, Phenix City and Fort Benning is required.

According to the calculated dissolved oxygen profile shown in Figure 12, (C), primary treatment, or 35 per cent BOD removal, of all sewage loads now existing would satisfy the dissolved oxygen objective. Secondary treatment, or approximately 75 per cent BOD removal, of all loads appears to provide a reasonable margin of dissolved oxygen above this minimum. Calculations also show that 75 per cent BOD removal of Columbus and Phenix City loads and 35 per cent of the Fort Benning load also results in a relatively wide margin above the minimum objective.

Future Pollution

It appears, as shown in Figure 13, that the predicted 1977 population loads from the Columbus and Phenix City area would necessitate secondary treatment in order to retain a dissolved oxygen concentration above 4 ppm in all sections of the river. Primary treatment of Fort Benning loads, in conjunction with secondary treatment of Columbus and Phenix City wastes, would still result in a margin of dissolved oxygen above 4 ppm as observed from these calculations.

Based upon survey data and office calculations, it is evident that, with present pollution loads and with present river conditions,

primary treatment of all waste loads should be provided to maintain the arbitrary dissolved oxygen level of 4.0 ppm with a 600 cfs discharge. However, prior to 1977, based on population predictions for that date, Columbus, Georgia, and Phenix City, Alabama, would have to provide secondary (75 per cent) treatment to maintain 4.0 ppm of dissolved oxygen with a discharge of 600 cfs in a free flowing river.

Considerable improvement in bacterial quality of river water can be accomplished from both primary and secondary treatment of sewage. Generally, a 50 per cent reduction in coliform concentration is obtained by primary treatment and 90 per cent by secondary treatment. Coliform removal of this magnitude would restore a large portion of the lower Chattahoochee River to a suitable quality for future domestic raw water supplies and other uses. Disease hazards would be much reduced, and the threat of bacterial contamination of Apalachicola Bay oysters from Chattahoochee River sources would be virtually eliminated.

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APPENDIX I

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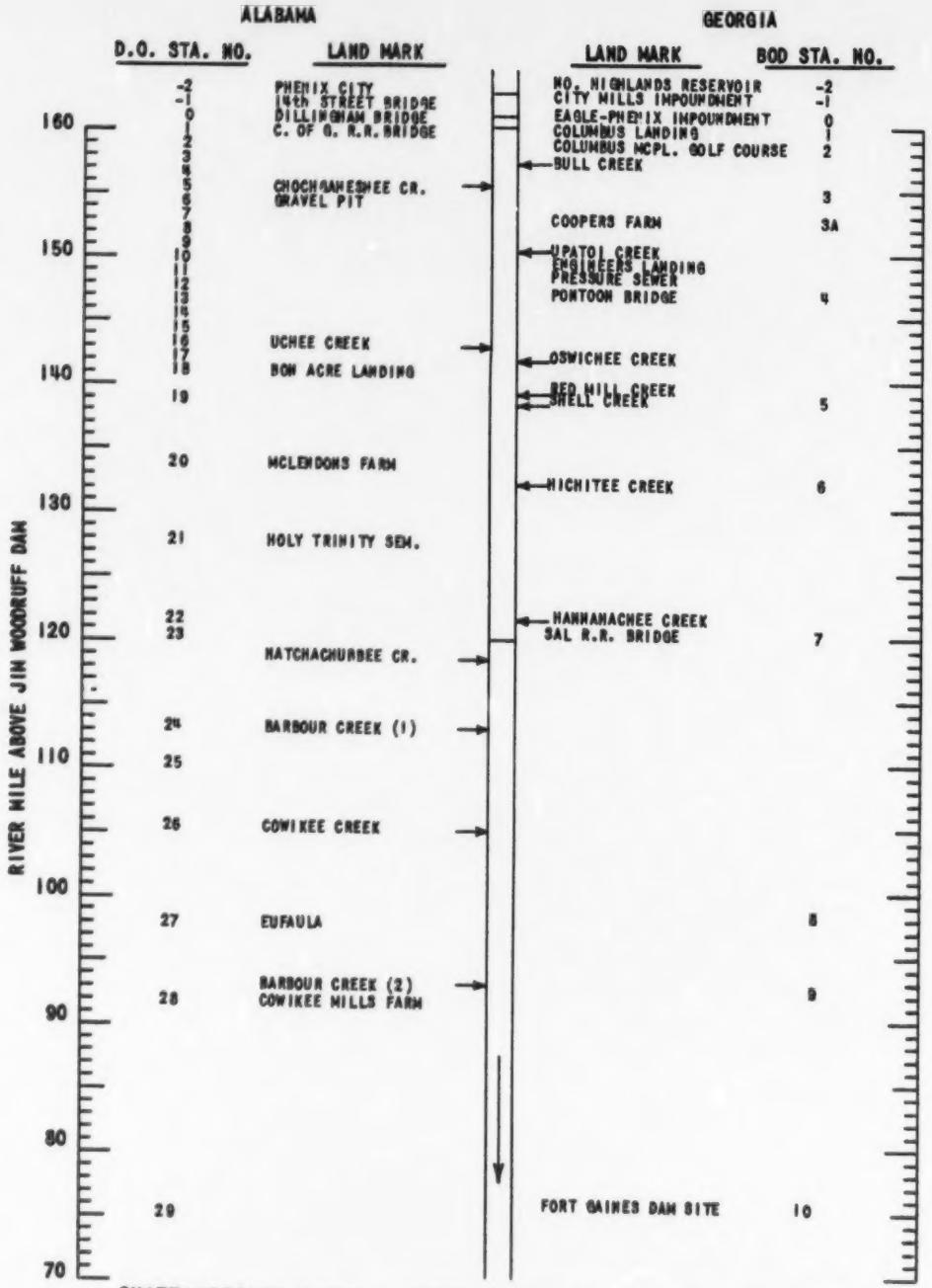
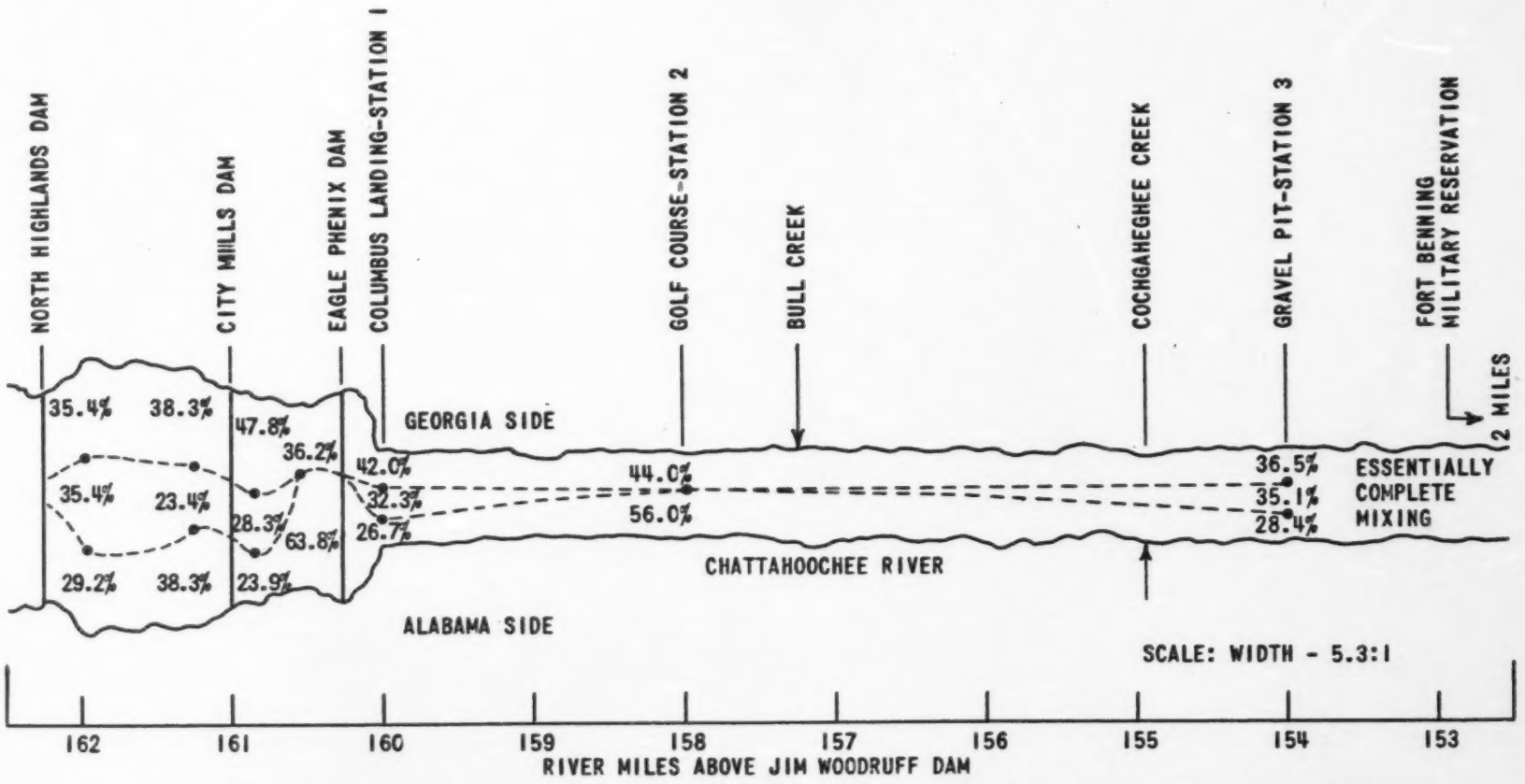
Cross-stream Distribution of Waste Loads 1a



CHATTAHOOCHEE RIVER - SURVEY LANDMARKS AND SAMPLING STATIONS

Figure 1



CHATTAHOOCHEE RIVER - DISTRIBUTION OF WASTE LOADS - COLUMBUS, GA. AND PHENIX CITY SECTION
SHOWING PER CENT OF TOTAL LOAD CROSS-STREAM AND APPROXIMATE DISTANCE TO COMPLETE MIXING
1958 SURVEY

Figure 1a

APPENDIX II

Water Quality and Flow Data

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Analysis of composite samples by date and time of sampling

1957 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	Susp. Solids ppm	* ppm La	Com-posite No.
9/16	1030	160	7.10	28.0					
	1450		7.10	29.0					
	1840		6.70	28.0	7.65	22.0	9.6	2.84	1a
	2400	160	6.80	27.5					
9/17	0650		6.80	27.5					
	0650		6.65	27.5	7.70	24.0	9.2	3.05	1b
9/16	0955	158	6.55	28.0					
	1425		6.25	28.0					
	1820		5.35	28.0	7.20	23.0	10.4	5.18	2a
	2300	158	5.05	28.0					
9/17	0620		5.15	28.0					
	0620		5.60	28.0	7.05	24.0	16.4	3.22	2b
9/16	0915	154	5.40	27.0					
	1350		7.10	28.0					
	1750		6.65	28.0	7.20	22.0	12.6	2.82	3a
	2230	154	4.20	28.0					
9/17	0420		4.15	27.0					
	0420		4.00	27.0	6.95	22.0	14.6	3.34	3b
	0830	146.5	5.35	28.0					
	1305		6.80	28.0					
	1715		7.45	28.0	6.95	18.0	14.2	1.55	4a
	2135	146.5	6.15	28.0					
9/17	0420		4.15	27.0					
	0420		4.00	27.0	6.95	22.0	15.2	1.69	4b
9/16	0730	138	6.10	28.0					
	1210		8.40	28.0					
	1625		8.75	27.0	6.90	16.5	98.8	2.18	5a
	2040	138	6.80	28.0					
9/17	0315		5.15	27.5					
	0315		5.30	27.5	6.85	17.5	17.8	1.55	5b
9/17	1120	160	6.90	28.0					
	1435		6.80	28.0					
	1730		7.05	28.0	7.50	22.0	13.8	3.94	6a
	2130		7.25	27.5					

* Ultimate first stage BOD

Analysis of composite samples by date and time of sampling (continued)

1957 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	Susp. Solids ppm	* ppm L_a	Com-posite No.
9/18	0040		7.05	27.0					
	0500		7.00	27.0	7.10	22.0	9.0	2.04	6b
9/17	1055	158	6.10	28.0					
	1410		6.05	28.0					
	1710		5.75	28.0	7.20	23.5	11.2	4.70	7a
	2120	158	6.55	28.0					
	2400		6.45	27.5					
9/18	0400		6.55	27.0	7.00	20.5	12.4	2.23	7b
9/17	1020	154	4.85	28.0					
	1305		6.35	28.0					
	1640		6.10	28.0	7.20	24.0	9.6	2.85	8a
	2020	154	4.85	28.0					
	2335		4.90	28.0					
9/18	0400		5.50	27.5	6.90	21.5	12.2	3.18	8b
9/17	0940	146.5	4.15	27.0					
	1125		5.20	28.0					
	1610		6.25	28.0	6.80	19.5	10.8	2.45	9a
	1925	146.5	6.10	28.0					
	2255		4.30	28.0					
9/18	0310		4.50	26.5	6.85	21.5	14.0	2.39	9b
**9/17	0840	138	4.60	26.0	-	-	-		
9/18	0825	160	7.10	27.0					
	1150		7.10	28.0					
	1650		7.10	27.0	7.25	22.5	26.0	4.80	10a
	2215	160	7.80	27.0					
9/19	0205		7.95	26.5					
	0600		7.85	26.5	7.25	21.5	27.6	1.72	10b
9/18	0805	158	6.30	27.0					
	1125		6.15	28.0					
	1620		6.15	28.0	7.05	23.5	11.0	3.82	11a
	2145	158	7.45	27.0					
9/19	0140		7.85	26.0					
	0520		7.85	26.0	6.95	20.5	36.8	1.66	11b

* Ultimate first stage BOD
** Became inaccessable

Analysis of composite samples by date and time of sampling (continued)

1957 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	Susp. Solids ppm	* ppm La	Com-posite No.
9/18	0730	154	6.55	27.0					
	1105		5.75	28.0					
	1540		5.45	28.0	7.05	22.5	9.4	2.12	12a
	2030	154	5.40	27.0					
9/19	0100		6.85	26.5					
	0445		7.15	26.0	6.85	20.0	43.6	2.75	12b
9/18	0700	146.5	4.00	27.0					
	1010		5.85	28.0					
	1425		6.75	28.0	6.90	19.5	--	4.12	13a
	1930	146.5	6.30	28.0					
	2400		5.00	27.0					
9/19	0400		6.20	27.0	6.70	18.5	50.0	2.02	13b
9/19	0850	160	7.70	26.0					
	1230		7.50	27.0					
	1745		7.70	27.0	7.20	23.0	12.8	2.43	14a
	2100	160	7.75	27.5					
9/20	0215		7.80	26.5					
	0500		8.10	26.5	7.25	22.5	13.6	2.18	14b
9/19	0830	158	7.60	26.0					
	1210		7.30	27.0					
	1730		7.20	26.0	7.25	23.0	18.8	2.80	15a
	2030	158	7.60	27.0					
	2400		7.45	26.5					
9/20	0430		7.75	26.5	7.05	22.0	38.0	2.43	15b
9/19	0800	154	7.00	26.0					
	1140		7.25	26.0					
	1640		6.70	27.0	7.10	22.0	17.6	1.87	16a
	1950	154	6.90	26.5					
	2315		6.90	27.0					
9/20	0345		7.00	26.5	6.95	20.5	14.8	2.62	16b
9/19	0720	146.5	6.60	26.0					
	1100		6.75	27.0					
	1530		7.10	27.0	7.00	19.0	28.4	1.87	17a

* Ultimate first stage BOD

Analysis of composite samples by date and time of sampling (continued)

1957 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	Susp. Solids ppm	* ppm L_a	Com-posite No.
	1900	146.5	6.60	27.5					
	2230		6.35	27.0					
9/20	0255		6.50	26.5	6.95	20.0	22.4	1.72	17b
9/23	0910	162.8	7.15	26.5					
	1300		8.50	28.0					
	1700		8.65	28.0	7.25	21.5	10.6	1.32	18
9/23	0815	160.8	7.50	27.5					
	1205		7.85	28.0					
	1615		8.00	28.0	7.05	21.0	8.8	1.19	19
9/23	0830	160	7.30	27.5					
	1220		7.75	28.0					
	1630		7.75	28.0	7.25	22.5	--	2.42	20
10/3	1020	160	8.10	22.0					
	1450		8.30	22.0					
	1750		8.35	22.0	7.10	20.0	9.6	2.53	21
10/3	1000	158	8.20	22.5					
	1430		8.15	22.0					
	1730		8.30	22.5	7.05	20.0	16.4	2.23	22
10/3	1350	154	7.75	22.0					
	1640		7.60	23.0	6.95	19.5	14.8	1.90	23
10/3	0850	146.5	7.85	22.0					
	1240		7.75	22.0					
	1630		7.70	23.0	6.80	17.5	19.6	1.42	24
10/3	1030	133	7.25	22.5					
	1440		7.50	23.0	6.80	18.0	36.4	1.16	25
10/3	0930	120	6.70	22.5					
	1320		7.20	23.0	6.80	17.5	34.4	0.99	26
10/3	0845	97.5	7.25	22.5					
	1220		7.30	22.5	6.60	18.0	28.4	0.96	27
10/4	0930	160	8.65	21.0					
	1345		8.15	21.0					
	1715		8.70	20.0	6.85	18.0	11.2	2.62	28

* Ultimate first stage BOD

Analysis of composite samples by date and time of sampling (continued)

1957 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	Susp. Solids ppm	* ppm L_a	Com-posite No.
10/4	0915	158	8.60	21.0					
	1320		8.80	20.5					
	1645		8.65	20.0	6.80	18.0	10.8	3.12	29
10/4	0840	154	8.00	22.0					
	1240		8.25	21.0					
	1600		8.15	21.0	6.80	18.5	16.0	2.04	30
10/4	0745	146.5	7.70	21.5					
	1200		7.80	21.0					
	1515		8.10	21.0	6.60	16.0	18.0	1.12	31
10/4	1010	138	7.55	22.0					
	1435		7.70	22.0	6.75	17.0	23.2	1.13	32
10/4	1030	133	7.30	22.0					
	1500		7.55	22.0	6.80	17.0	22.0	1.22	33
10/4	1120	120	7.00	22.0					
	1545		7.25	22.0	6.75	16.0	26.4	1.69	34
10/5	0945	160	8.95	20.0					
	1420		9.70	21.0					
	1700		9.00	21.0	7.20	18.0	13.6	1.80	35
10/5	0850	158	8.55	20.0					
	1400		8.20	21.5					
	1540		9.00	21.0	7.20	18.0	12.4	2.05	36
10/5	0830	154	8.35	20.0					
	1315		8.55	21.0					
	1600		8.65	21.0	7.15	17.5	16.0	2.26	37
10/5	0755	146.5	8.10	20.0					
	1225		8.20	20.5					
	1520		8.55	21.0	7.15	15.5	16.4	1.03	38
10/5	1100	138	8.15	20.0					
	1515		8.35	20.0	7.25	16.5	26.8	0.89	39
10/5	1045	133	7.95	20.0					
	1340		8.25	20.0	7.25	16.0	26.4	0.94	40

* Ultimate first stage BOD

Analysis of composite samples by date and time of sampling (continued)

1957 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	Susp. Solids ppm	* ppm L_a	Com-posite No.
10/5	0945	120	7.45	20.0					
	1300		7.65	20.0	7.30	19.0	31.6	0.55	41
10/9	0800	162.8	8.30	19.5					
	1045		8.80	20.5					
	1415		8.70	21.0					
	1710		8.55	21.0	6.95	16.0	--	0.81	42a
	2000	162.8	8.55	20.5					
	2300		8.50	20.5					
10/10	0200		8.55	20.5					
	0500		8.45	20.0	7.00	16.0	--	0.92	42b
10/9	0830	160.8	8.70	20.0					
	1110		8.65	20.5					
	1450		9.00	21.0					
	1730		8.90	21.0	7.00	16.0	--	1.42	43a
	2230	160.8	9.00	21.0					
	2320		8.50	21.0					
10/10	0230		9.00	20.5					
	0530		8.95	20.0	7.00	16.5	--	0.89	43b
10/9	0900	160	8.60	20.0					
	1130		8.60	20.5					
	1515		8.95	21.0					
	1750		8.85	21.0	7.40	17.0	--	1.89	44a
10/9	2115	160	8.90	21.0					
	2400		8.65	21.0					
10/10	0300		8.90	20.5					
	0600		8.70	20.5	7.60	18.5	--	1.68	44b
10/9	0920	158	8.40	20.0					
	1150		8.55	20.5					
	1540		8.70	21.0					
	1810		8.65	21.0	7.25	19.0	--	2.23	45a
	2130	158	8.75	21.0					
10/10	0020		8.60	21.0					
	0315		8.65	20.5					
	0615		8.65	20.0	7.30	19.5	--	2.00	45b

* Ultimate first stage BOD

Analysis of composite samples by date and time of sampling (continued)

1957 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	Susp. Solids ppm	* ppm La	Com-posite No.
10/10	0800	162.8	8.40	20.0					
	1100		8.95	20.5					
	1450		8.80	22.0					
	1650		9.75	22.0	6.90	16.0	--	0.38	46a
	2000	162.8	8.45	22.0					
	2300		8.65	21.0					
10/11	0215		8.70	20.5					
	0445		8.55	20.5	6.95	16.0	--	0.66	46b
10/10	0830	160.8	8.85	20.0					
	1115		8.70	21.0					
	1520		8.85	22.0					
	1720		8.95	21.5	6.90	16.5	--	0.90	47a
	2100	160.8	8.80	21.5					
	2300		8.95	21.0					
10/11	0245		8.85	20.5					
	0500		8.80	20.5	7.00	16.0	--	0.58	47b
10.10	0850	160	8.60	20.0					
	1130		8.60	21.0					
	1540		8.65	22.0					
	1730		8.70	21.0	7.45	20.5	--	1.75	48a
	2130	160	8.60	21.5					
	2400		8.75	21.5					
10.11	0305		8.65	20.5					
	0530		8.70	21.0	7.50	19.0	--	2.55	48b
10/10	0905	158	8.55	20.0					
	1150		8.60	21.0					
	1555		8.50	21.0					
	1745		8.50	21.0	7.00	18.0	--	3.20	49a
	2140	158	8.50	20.5					
10/11	0015		8.60	21.0					
	0320		8.60	20.5					
	0545		8.45	20.5	7.20	19.0	--	2.23	49b
10/16	0845	160	8.25	20.0					
	1000		8.30	20.0					
	1520		8.25	20.5	7.55	20.5	--	4.30	50

* Ultimate first stage BOD

Analysis of composite samples by date and time of sampling (continued)

1957 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	Susp. Solids ppm	* ppm L_a	Com-posite No.
10/16	1030	146.5	7.25	20.0					
	1315		7.40	20.5					
	1600		7.50	20.5	6.95	17.0	--	1.94	51
10/16	0950	120	7.80	20.0					
	1420		7.10	20.5	6.85	16.5	--	1.18	52
10/16	1530	97.5	7.70	20.5	6.90	18.0	--	1.13	53
10/16	1110	92.0	7.60	20.0	6.95	17.0		0.60	54

* Ultimate first stage BOD

Analysis of composite samples by date and time of sampling (continued)

1958 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	5-Day BOD ppm	* ppm L_a	Com-posite No.
8/14	1825	162.8	7.15	28.5					55
	2225		6.85	28.0					
8/15	0200		6.85	27.5	7.20	16.6	0.95	1.01	
8/14	1855	160.0	7.60	28.5					56
	2300		7.65	28.0					
8/15	0225		7.75	27.5	6.80	14.5	1.15	1.25	
8/14	1905	158.0	7.40	28.5					57
	2315		7.50	28.5					
8/15	0245		7.60	28.0	7.00	15.8	1.55	0.97	
8/14	1925	154.0	6.90	28.0					58
	2350		7.20	28.0					
8/15	0315		7.25	28.0	6.80	14.5	1.70	1.44	
8/14	1840	146.5	6.20	28.0					59
	2140		6.15	27.0					
8/15	0200		6.55	27.0	7.25	17.0	1.60	1.14	
8/14	1905	138.0	6.60	28.0					60
	2215		6.50	27.5					
8/15	0230		6.10	27.0	7.20	17.0	1.15	1.00	
8/14	1920	133.0	6.60	28.0					61
	2315		6.30	28.0	7.15	15.7	0.90	0.89	
8/15	1755	162.8	7.05	30.0					62
	2205		6.80	28.5					
8/16	0200		6.75	27.5	7.20	16.0	0.70	1.07	
8/15	1835	160.0	7.40	30.0					63
	2240		7.55	29.5					
8/16	0235		7.65	28.5	7.20	16.5	0.90	0.97	
8/15	1845	158.0	7.40	30.0					64
	2255		7.45	29.5					
8/16	0250		7.40	29.0	7.10	16.5	1.65	0.72	
8/15	1915	154.0	7.00	29.5					65
	2320		7.00	--					
8/16	0330		7.00	29.0	7.15	17.0	1.35	0.60	

* Ultimate first stage BOD

Analysis of composite samples by date and time of sampling (continued)

1958 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	5-Day BOD ppm	* ppm L_e	Com-posite No.
8/15	1800	146.5	6.75	28.5					66
	2230		6.45	26.0					
8/16	0400		6.35	27.5	7.15	16.5	2.60	2.12	
8/15	1925	138	6.70	28.0					67
	0110		6.00	27.0					
8/16	0300		6.30	27.0	5.95	5.0	1.20	1.05	
8/15	2030	133.0	6.90	28.0					68
	0210		6.10	27.5					
8/16	0230		6.10	27.0	7.00	16.5	2.50	1.93	
8/16	1755	162.8	6.80	27.5					69
	2155		6.70	30.0					
8/17	0200		6.70	28.5	7.10	16.0	0.65	0.70	
8/16	1835	160.0	7.40	28.5					70
	2225		7.50	30.0					
8/17	0225		7.60	28.5	6.20	15.7	1.50	1.23	
8/16	1850	158.0	7.40	28.5					71
	2240		7.50	28.5					
8/17	0240		7.60	28.0	7.00	15.8	1.15	0.62	
8/16	1905	154.0	7.15	29.5					72
	2300		7.00	30.0					
8/17	0300		7.15	29.0	7.00	16.0	1.20	0.68	
8/16	1800	146.5	6.80	28.0					73
	2200		6.90	28.0					
8/17	0130		6.80	28.0	7.00	16.0	1.05	1.05	
8/16	1905	138.0	6.55	28.5					74
	2300		6.25	28.5					
8/17	0200		6.25	28.0	7.00	15.7	1.25	1.17	
8/16	1925	133.0	6.90	28.0					75
	2330		6.40	28.5					
8/17	0220		6.05	27.5	7.10	15.1	0.90	0.56	
8/19	0550	162.8	7.00	26.0					76
	1000		7.40	27.0					
	1400		7.70	28.5	7.30	17.5	0.85	0.65	

* Ultimate first stage BOD

Analysis of composite samples by date and time of sampling (continued)

1958 date	Time	River Mile**	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	5-Day BOD ppm	* ppm L_a	Com-posite No.
8/19	0710	160.0	7.70	26.5					77
	1055	Left	7.70	27.5			2.10		
	1455		8.00	28.0					
8/19	0705	160.0	7.60	26.5					
	1050	Middle	7.50	27.5	7.30	17.5	1.90	1.82	
	1440		7.85	28.0					
8/19	0700	160.0	7.60	26.5					
	1045	Right	7.40	28.0			3.10		
	1435		7.70	28.0					
8/19	0725	158.0	7.45	26.5					78
	1115	Left	7.70	27.5			1.50		
	1455		7.75	27.5					
8/19	0720	158.0	7.45	26.5					
	1110	Middle	7.65	27.5	7.30	17.5	1.50	1.24	
	1452		7.75	28.0					
8/19	0715	158.0	7.25	26.5					
	1105	Right	7.45	27.5			2.05		
	1450		7.60	28.0					
8/19	0755	154.0	7.05	27.0					79
	1140	Left	7.45	28.0			1.65		
	1520		7.35	28.0					
8/19	0750	154.0	7.05	27.0					
	1135	Middle	7.45	27.5	7.20	17.0	1.95	1.08	
	1517		7.20	28.0					
8/19	0745	154.0	6.95	26.5					
	1130	Right	7.30	28.0			1.95		
	1515		7.04	28.0					
8/19	0630	146.5	6.35	28.0					80
	1030		6.60	29.0					
	1330		7.10	29.0	7.35	17.0	1.70	1.28	
8/19	0710	138.0	6.25	27.5					81
	1100		6.25	28.5					
	1400		6.60	29.0	7.15	14.5	1.80	1.40	
8/19	0745	133.0	5.85	28.0					82
	1120		6.15	28.5					
	1415		6.40	29.5	7.10	15.0	2.40	2.18	

* Ultimate first stage BOD

** Left, Middle, and Right indicate quarter point samples.

Analysis of composite samples by date and time of sampling (continued)

1958 date	Time	River Mile**	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	5-Day BOD ppm	* ppm La	Com-posite No.
8/20	0600	162.8	6.95	26.0					83
	1000		7.30	27.0					
	1355		7.75	29.0	7.30	17.0	0.95	1.27	
8/20	0705	160.0	7.60	27.0					84
	1035	Left	7.50	27.5			1.35		
	1425		7.70	28.0					
8/20	0700	160.0	7.50	27.0					
	1033	Middle	7.25	27.5	7.45	18.5	2.15	1.55	
	1420		7.40	28.0					
	0655	160.0	7.55	27.0					
	1030	Right	7.10	27.5			1.85		
	1415		7.30	28.0					
8/20	0725	158.0	7.45	27.0					85
	1050	Left	7.20	27.5			1.30		
	1445		7.45	28.0					
8/20	0720	158.0	7.20	27.0					
	1047	Middle	6.85	27.5	7.30	18.0	1.40	1.53	
	1440		6.90	28.0					
8/20	0715	158.0	7.30	26.5					
	1045	Right	7.45	27.0			2.55		
	1435		7.75	27.5					
8/20	0750	154.0	7.15	27.0					86
	1115	Left	7.00	28.0			1.65		
	1510		6.75	28.0					
8/20	0745	154.0	7.10	27.0					
	1112	Middle	6.90	28.0	7.30	18.0	1.95	1.05	
	1505		6.50	28.5					
8/20	0740	154.0	7.00	27.0					
	1110	Right	6.90	27.5			1.90		
	1500		6.40	28.0					
8/20	0630	146.5	6.35	28.5					87
	0930		6.20	29.0					
	1315		6.80	29.5	7.20	16.5	1.55	1.05	
8/20	0700	138.0	6.15	28.5					88
	1005		6.05	30.0					
	1315		6.55	29.5	7.20	16.0	1.25	1.07	

* Ultimate first stage BOD

** Left, Middle, and Right indicate quarter point samples.

Analysis of composite samples by date and time of sampling (continued)

1958 date	Time	River Mile**	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	5-Day BOD ppm	* ppm La	Com-posite No.
8/20	0715	133.0	6.15	28.0					89
	1020		6.00	28.7					
	1355		6.+	29.5	7.10	16.0	3.00	2.70	
8/21	0600	162.8	6.95	26.0					90
	0945		7.30	26.5					
	1405		7.70	28.0	7.30	17.0	0.90	1.05	
8/21	0700	160.0	7.50	26.5					91
	1020	Left	7.60	27.5			1.50		
	1400		7.90	27.5					
8/21	0657	160.0	7.45	26.5					
	1015	Middle	7.50	27.5	7.35	18.0	2.00	2.12	
	1338		7.75	27.5					
8/21	0655	160.0	7.20	26.5					
	1010	Right	7.35	27.5			2.65		
	1335		7.50	27.5					
8/21	0710	158.0	7.30	26.5					92
	1035	Left	7.45	27.0			1.65		
	1500		7.75	27.5					
8/21	0717	158.0	7.20	26.5					
	1030	Middle	7.45	27.0	7.35	18.5	1.60	1.60	
	1457		7.70	27.5					
8/21	0715	158.0	6.70	26.5					
	1025	Right	6.90	27.0			2.45		
	1455		7.20	27.5					
8/21	0740	154.0	6.90	26.5					93
	1100	Left	7.00	27.5			2.35		
	1525		6.95	28.0					
8/21	0737	154.0	6.90	26.5					
	1055	Middle	6.95	27.5	7.35	18.5	3.15	3.22	
	1522		6.85	28.0					
8/21	0735	154.0	6.70	26.5					
	1050	Right	6.85	28.0			3.45		
	1520		6.70	28.0					
8/21	0645	146.5	6.15	28.5					94
	1015		6.40	29.0					
	1330		6.75	29.5	7.25	17.0	1.75	1.15	

* Ultimate first stage BOD

** Left, Middle, and Right indicate quarter point samples.

Analysis of composite samples by date and time of sampling (continued)

1958 date	Time	River Mile	D.O. ppm	Temp. °C	pH	Total Alka-linity ppm	5-Day BOD ppm	* ppm L_a	Com-posite No.
8/21	0715	138.0	6.00	28.0					95
	1040		6.10	29.0					
	1400		6.55	30.0	--	--	1.65	1.19	
8/21	0730	133.0	5.90	28.0					96
	1100		6.05	29.0					
	1415		6.50	30.0	7.25	17.0	1.55	0.94	

* Ultimate first stage BOD

Miscellaneous Dissolved Oxygen, Temperature and BOD - Established Stations

1957 date	Time	River Mile	D.O. ppm	Temp. °C	BOD 5 Day	BOD Other	
9/11	1015	160	7.30	27.0			
10/8	0815	160	8.75	20.0	1.45		
10/18	0745	160	8.40	20.0			
9/11	1030	158	6.68	27.0			
10/8	0830	158	8.60	20.0	2.05		
10/18	0750	158	8.30	20.0			
9/11	1145	154	6.10	27.0		2.40	(4-day)
10/8	0905	154	8.40	20.0	1.80		
	0930		8.45	20.0			
10/18	0800	154	7.40	20.0			
9/10	1030	146.5	4.50	27.0	2.00	1.45	(2-day)
	1035		4.55	27.0	2.30	1.35	" "
	1040		4.05	27.0	1.95	1.35	" "
	1045		5.15	27.0	2.15	1.30	" "
	1050		4.45	27.0			
	1100		4.50	27.0			
9/11	1320	146.5	5.55	27.0		1.70	(4-day)
9/12	0925	146.5	5.20	27.0		0.75	(3-day)
10/8	1015	146.5	7.90	20.0	1.85		
10/14	0800	146.5	7.55	18.0			
	0900		7.85	18.5	1.65		
	1000		8.10	19.0			
	1100		8.15	19.5			
	1200		8.30	20.0			
	1300		8.45	20.0	1.60		
	1400		8.55	20.5			
	1500		8.60	21.0			
10/14	1600	146.5	8.40	21.0			
	1700		8.60	21.0	1.60		
	1800		8.45	20.5			
	1900		8.35	20.5			
	2000		8.30	20.0			
	2100		7.90	20.0	1.90		
	2200		7.85	20.0			
	2300		7.70	20.0			

Miscellaneous Dissolved Oxygen, Temperature and BOD - Established Stations (continued)

1957 date	Time	River Mile	D.O. ppm	Temp. °C	BOD 5 Day	BOD Other
10/14	2400	146.5	7.40	19.0		
10/15	0100		7.30	19.5	2.50	
	0200		7.40	19.0		
	0300		7.50	19.0		
	0400		7.20	19.0		
	0500		7.40	19.0	2.00	
	0600		7.30	19.0		
	0700		7.60	19.0		
10/18	0800	146.5	6.90	20.0		
9/12	1010	138	4.70	27.0		0.70 (3-day)
10/8	1115	138	7.85	20.0	1.60	
10/18	0900	138	6.25	20.0		
9/12	1045	133	4.90	27.0		
10/8	1135	133	7.85	20.0	1.65	
10/18	0920	133	6.30	20.0		
9/12	1200	120	5.90	28.0		1.30 (3-day)
	1350		6.05	28.0		
10/8	1215	120	7.45	20.0	1.60	
	1315		7.80	20.0		
10/18	1000	120	6.30	20.5		
9/12	1540	97.5	7.15	28.0		1.05 (3-day)
10/8	1435	97.5	8.05	20.5	1.30	
10/18	1145	97.5	7.20	21.0		
10/18	1335	92.0	7.55	21.0		
10/18	1450	75.0	7.95	21.5		

Miscellaneous Dissolved Oxygen, Temperature and BOD -
Established Stations (continued)

1958 date	Time	River Mile	D.O. ppm	Temp. °C.	5-Day BOD
8/26	0945	162.8	6.75	26.1	0.55
8/27	1000		7.30	26.7	1.45
9/1	0815		7.00	26.0	0.40
8/26	1120	154.0	7.00	26.3	0.75
8/27	1230		6.75	27.5	2.75
9/1	1005		7.20	27.8	1.25
8/26	1200	146.5	6.82	26.4	1.55
8/27	1300		6.95	28.0	2.20
9/1	1040		6.90	28.1	1.30
8/26	1105	138.0	6.40	28	1.30
8/27	1105		6.50	27.2	1.60
9/1	0930		6.60	28	0.50
8/26	1130	133.0	6.44	28	1.15
8/27	1125		6.55	27.0	1.60
9/1	1000		6.70	27.4	0.35

Miscellaneous Dissolved Oxygen and Temperature - Intermediate Stations

1957 date	Time	River Mile	D.O. ppm	Temp. °C
9/24	0630	159	7.55	26.0
10/8	0825		8.80	20.0
9/24	0700	157	7.10	26.0
10/8	0845		8.70	20.0
10/18	0755		8.10	20.0
9/24	0715	156	6.85	26.0
10/8	0850		8.50	20.0
9/24	0725	155	6.75	26.0
10/8	0900		8.40	20.0
9/24	0745	153	6.55	26.5
10/8	0915		8.50	20.0
9/24	0815	151	6.40	26.0
10/8	0940		8.50	20.0
10/18	0810		7.20	20.0
9/24	0825	150	6.35	26.0
10/8	0945		8.40	20.0
9/24	0845	149	6.30	26.0
10/8	0950		8.40	20.0
10/18	0820		7.15	20.0
9/24	0855	148	6.30	26.0
10/8	1000		8.30	20.0
9/24	0930	145	6.30	26.0
10/8	1030		7.50	20.0
10/8	1035	144	8.10	20.0
9/24	0955	143	6.15	26.0
	1040		7.80	20.0
	0845		6.50	20.0
9/24	1005	141.5	6.35	26.0
10/8	1045		7.80	20.0
9/24	1130	128	7.10	26.0
10/5	1030		7.70	20.0
10/8	1200		7.60	20.0
10/18	0935		6.30	20.0

Miscellaneous Dissolved Oxygen and Temperature -
Intermediate Stations (continued)

1957 date	Time	River Mile	D.O. ppm	Temp. °C
9/24	1205	122	8.20	26.0
9/24	1420	113	9.55	26.0
10/8	1345		7.60	20.5
10/16	0930		7.10	20.0
10/16	1400		7.50	20.5
10/18	1100		6.80	20.5
9/24	1445	110	9.50	26.0
10/8	1400		7.80	20.5
9/24	1510	105	9.70	26.5
10/8	1415		7.85	20.5
10/18	1125		6.90	21.0
10/16	1140	96.5	7.60	20.0
10/16	1620		7.70	20.5
10/18	1315		7.35	21.0
10/18	1350	87.0	7.85	21.5
10/18	1410	82.0	8.00	21.5

Miscellaneous Dissolved Oxygen, Temperature and BOD -
Intermediate Stations

1958 date	Time	River Mile*	D.O. ppm	Temp. °C	5-Day BOD
8/28	0900	160.5	7.25	26.0	0.60
	1115		7.80	26.5	0.70
	1425		8.00	27.5	0.55
9/1	0900		7.30	27.5	
8/26	1045	160.2	7.30	26.0	2.20
8/27	1115		7.30	27.0	1.60
9/1	0925		7.50	27.0	1.85
		158.5			
8/25	0816	Left	7.50	26.5	
	0814	Middle	7.45	26.5	1.50
	0812	Right	7.40	26.5	
	1115	Left	7.40	28.0	
	1113	Middle	7.35	28.0	1.95
	1110	Right	7.35	27.5	
	1520	Left	7.90	28.0	
	1517	Middle	7.75	28.0	1.65
	1515	Right	7.65	28.0	
8/26	1100		7.35	26.0	1.90
8/27	1210		7.30	27.5	1.65
9/1	0945		7.40	27.0	1.05
		157.0			
8/25	0835	Left	7.45	27.0	
	0832	Middle	7.40	27.0	1.25
	0830	Right	7.30	27.0	
	1135	Left	7.40	28.0	
	1133	Middle	7.40	28.0	1.85
	1130	Right	7.40	28.0	
	1540	Left	7.80	28.0	
	1537	Middle	7.60	28.0	1.95
	1535	Right	7.50	28.0	

* Left, Middle, and Right indicate quarter point samples.

Miscellaneous Dissolved Oxygen, Temperature and BOD -
Intermediate Stations (continued)

1958 date	Time	River Mile*	D.O. ppm	Temp. °C	5-Day BOD
		152.0			
8/25	0726	Left	7.30	29.0	
	0726	Middle	6.85	29.0	1.25
	0728	Right	6.80	29.0	
	1135	Left	7.10	29.5	
	1135	Middle	7.15	29.5	2.15
	1135	Right	7.15	29.5	
	1805	Left	6.90	29.5	
	1800	Middle	7.00	29.5	2.15
	1755	Right	6.90	29.5	
8/26	1150	128	6.30	27.5	1.30
8/27	1137		6.45	27.0	1.60
9/1	1030		6.70	27.5	0.50
8/26	1215	120	6.15	27.5	1.35
8/27	1200		6.15	27.0	1.60
9/1	1100		6.70	28.0	0.65
8/26	1255	108	6.30	28.0	1.25
8/27	1240		6.75	27.5	1.25
9/1	1130		7.00	28.5	0.20
8/26	1420	92	6.20	28.0	0.95
8/27	1440		6.90	28.0	2.05
9/1	1300		7.30	28.5	0.90
8/26	1510	75	6.75	27.5	0.65
8/27	1530		6.60	28.0	1.60
9/1	1400		7.50	29.0	1.00

* Left, Middle, and Right indicate quarter point samples.

Long Term BOD Data (Averages of Duplicate Samples - ppm)

Days	Composite Number*							
	1a	1b	2a	2b	3a	3b	4a	4b
1	1.30	0.80	1.88	1.30	0.80	1.03	0.80	0.65
2	1.85	1.30	3.20	2.00	1.30	1.75	1.10	1.10
3	2.25	1.76	3.85	2.70	1.73	2.25	1.30	1.35
4	2.60	2.16	4.40	3.40	2.08	2.55	1.45	1.60
5	3.15	2.36	4.93	3.80	2.45	2.95	1.90	1.95
7	3.65	2.71	5.13	--	2.95	3.80	2.20	2.40
9	4.05	3.13	6.20	4.40	3.25	4.15	2.60	2.85
11	4.30	3.36	6.58	5.15	3.50	4.90	2.70	3.15
13	4.90	3.63	6.70	5.50	3.70	5.15	2.95	3.50
15	5.05	4.03	6.75	5.65	4.15	5.90	3.05	3.70
	5a	5b	6a	6b	7a	7b	8a	8b
1	0.95	0.70	1.45	0.70	1.95	0.90	1.30	1.20
2	1.45	1.00	2.30	1.05	2.90	1.40	1.90	1.95
3	1.75	1.25	2.75	1.60	3.45	1.75	2.25	2.25
4	2.05	1.50	3.25	1.65	4.15	2.20	2.75	2.65
5	2.65	2.00	3.40	1.70	4.30	2.55	2.75	2.90
7	3.05	2.35	3.90	2.10	4.85	2.95	3.35	3.25
9	3.35	2.90	4.15	2.48	5.40	3.45	3.65	3.55
11	3.60	3.10	4.55	2.65	5.80	3.65	4.15	3.85
13	3.50	3.10	4.85	2.85	6.10	4.05	4.50	4.50
15	3.90	3.88	4.95	3.00	6.45	4.45	--	4.65
20	--	--	5.65	3.40	--	4.70	6.30	5.30
	9a	9b	10a	10b	11a	11b	12a	12b
1	0.90	0.90	1.70	0.60	1.35	0.80	0.95	1.00
2	1.30	1.35	2.80	1.05	2.05	1.15	1.50	1.70
3	1.70	1.70	3.35	1.20	2.65	1.40	1.80	2.15
4	2.15	2.10	3.80	1.80	3.15	2.05	1.95	2.90
5	2.15	2.40	4.30	1.85	3.45	2.20	2.25	3.05
7	2.75	2.70	4.85	2.20	4.05	2.55	2.55	3.40
9	3.05	3.10	5.25	2.35	4.80	2.90	2.80	3.90
11	3.25	3.35	5.65	2.75	4.95	3.20	3.15	4.30
13	3.65	3.45	5.95	3.00	5.05	3.85	3.45	4.50
15	4.05	4.00	6.15	3.20	6.05	3.70	3.75	4.65
20	4.80	4.85	7.05	3.60	6.35	4.40	4.30	5.25

* See Appendix II, pages 1-7, Column 10

Long Term BOD Data (continued)

Days	Composite Number							
	13a	13b	14a	14b	15a	15b	16a	16b
1	0.85	1.10	0.90	0.85	1.00	1.05	0.55	0.60
2	1.15	1.95	1.45	1.25	1.70	1.50	1.10	1.30
3	1.60	2.55	1.90	1.90	2.30	2.10	1.40	1.80
4	1.70	3.30	2.15	1.95	2.65	2.50	1.50	2.00
5	1.90	3.55	2.50	2.25	3.10	2.90	1.75	2.10
7	2.30	3.95	2.80	2.55	3.45	3.25	2.10	2.50
9	2.65	4.15	3.15	2.85	3.90	3.70	2.45	3.15
11	2.95	4.55	3.50	3.50	4.30	4.10	3.00	3.45
13	3.05	4.70	3.80	3.45	4.95	4.55	3.40	3.60
15	3.05	5.05	4.05	4.10	5.50	4.60	3.60	3.75
20	3.90	5.60	5.05	4.05	5.60	5.45	3.90	4.25
	17a	17b	18	19	20	21	22	23
1	0.45	0.60	*0.75	*0.80	*1.65	1.15	1.15	0.75
2	0.75	1.10	0.80	1.00	1.80	1.60	1.60	1.10
3	1.15	1.55	1.00	1.05	2.10	2.00	2.10	1.40
4	1.30	1.80	1.10	1.35	2.65	2.35	2.70	1.80
5	1.55	1.95	1.20	1.60	2.95	2.65	2.95	2.05
7	1.80	2.30	1.55	2.05	3.45	3.15	3.35	2.40
9	2.05	2.85	1.95	2.30	3.78	3.55	3.80	2.70
11	2.40	3.20	2.20	2.55	4.15	3.80	4.05	3.00
13	3.35	3.35	2.30	2.80	4.45	4.25	4.65	3.50
15	3.15	3.55	2.55	3.00	4.75	4.75	4.85	3.40
20	3.35	4.00	3.05	3.00	5.45	5.20	5.30	3.90
	24	25	26	27	28	29	30	31
1	0.65	0.60	0.45	0.40	0.75	0.85	0.55	0.45
2	0.95	0.80	0.50	0.55	1.30	1.45	1.00	0.85
3	1.10	1.00	0.85	0.75	2.00	2.65	2.20	2.05
4	1.50	--	--	--	2.65	3.35	2.80	3.60
5	1.85	1.45	1.15	1.00	3.00	3.70	3.20	4.05
7	2.05	1.90	1.40	1.30	3.45	4.30	3.65	4.50
9	2.35	1.70	1.65	1.50	3.85	4.70	4.00	4.85
11	2.55	2.15	1.90	1.75	4.00	4.85	4.15	5.15
13	2.80	2.15	2.00	1.90	4.25	5.20	4.40	5.25
15	2.95	2.35	2.15	2.00	4.55	5.55	4.60	5.60
20	3.45	2.50	2.60	2.50	4.95	5.90	5.30	6.50

* -1.5 Days

Long Term BOD Data (continued)

Days	Composite Number							
	32	33	34	35	36	37	38	39
1	0.25	0.20	0.45	0.60	0.70	0.50	0.35	0.40
2	0.55	0.65	0.85	1.05	1.25	0.90	0.60	0.50
3	0.95	0.85	1.10	1.55	2.05	1.75	0.95	0.65
4	1.00	1.00	1.40	1.80	2.35	2.25	1.40	0.75
5	1.20	1.30	1.35	2.15	2.60	2.75	1.65	0.95
7	1.50	1.45	1.85	2.25	3.05	3.30	2.10	1.20
9	1.65	1.80	2.15	2.60	3.10	3.55	2.20	1.55
11	1.95	2.00	2.15	2.45	3.65	3.75	2.45	1.60
13	2.10	2.20	2.30	3.05	3.85	3.95	2.65	1.65
15	2.25	2.15	2.45	3.15	3.85	4.10	2.75	1.95
20	2.60	2.70	2.90	3.75	4.65	4.55	3.00	2.10
	40	41	42a	42b	43a	43b	44a	44b
1	0.35	0.20	0.45	0.40	0.60	0.55	0.80	0.65
2	0.55	0.30	0.50	0.50	1.00	0.55	1.35	1.15
3	0.75	0.45	0.65	0.70	1.15	0.75	1.50	1.50
4	1.05	0.50	0.90	0.80	1.35	0.90	1.85	1.75
5	1.15	0.70	0.90	1.00	1.60	1.10	2.30	1.95
7	1.45	0.65	1.10	1.25	2.00	1.50	2.75	2.25
9	1.60	0.95	1.35	1.60	2.30	1.70	3.05	2.55
11	1.85	1.05	1.55	1.80	2.40	1.80	3.10	2.90
13	1.90	1.15	1.65	1.90	2.65	1.90	3.30	3.30
15	2.25	1.30	*1.83	*2.00	*2.60	*2.20	*3.45	*3.25
20	2.45	1.50						
	45a	45b	46a	46b	47a	47b	48a	48b
1	0.90	1.00	0.15	0.30	0.40	0.30	0.75	0.80
2	1.50	1.35	0.20	0.35	0.65	0.40	1.05	1.35
3	1.90	2.05	0.40	0.55	1.00	0.45	1.50	1.60
4	2.25	2.35	0.45	0.65	1.05	0.55	1.95	1.80
5	2.60	2.70	0.60	0.80	1.20	0.90	2.15	2.45
7	3.05	3.05	0.80	1.05	1.60	1.30	2.55	2.80
9	3.40	3.40	0.95	1.40	1.80	1.35	2.85	3.15
11	3.85	3.65	1.10	1.40	2.00	1.65	3.15	3.45
13	4.15	4.10	1.15	1.40	2.25	1.55	3.40	3.70
15	*4.30	*4.25	1.40	1.80	2.40	1.80	3.70	3.90

* 14 Day

Long Term BOD Data (continued)

Days	Composite Number						
	49a	49b	50	51	52	53	54
1	1.45	0.90	1.70	0.65	0.50	0.60	0.30
2	2.25	1.55	3.45	1.25	0.70	0.80	0.40
3	2.90	2.00	4.45	1.90	0.85	0.90	0.55
4	3.50	2.15	5.35	2.75	1.15	1.05	0.80
5	3.70	2.70	5.50	3.20	1.30	1.20	0.80
7	4.35	2.30	6.00	3.55	1.25	1.40	1.05
9	4.80	3.40	6.45	3.93	1.50	1.50	1.20
11	5.10	3.85	6.70	4.23	1.55	1.60	1.30
13	5.60	3.90					
15	6.00	4.20					

Long Term BOD Data (continued)

Days	Composite Number*							
	55	56	57	58	59	60	61	62
1	0.75	0.30	0.35	0.25	0.40	0.30	0.60	0.45
2	0.70	0.35	0.45	0.40	1.10	0.55	0.80	0.40
3	0.80	0.80	0.45	0.50	1.45	0.50	0.70	0.75
5	0.95	0.70	0.65	0.80	0.95	0.90	1.15	0.90
7	1.15	0.90	0.90	1.10	1.20	0.90	1.55	1.25
9	1.50	1.15	1.10				1.85	1.40
10				1.40	1.35	1.10		
11		1.35	1.20				1.85	1.55
	63	64	65	66	67	68	69	70
1	0.55	0.75	0.55	0.70	0.65	0.55	0.30	0.55
2	0.90	1.25	0.90	1.15	0.85	0.65	0.65	0.85
3	0.95	1.45	1.35	1.60	0.90	1.05	0.70	1.15
5	1.50	2.15	1.90	2.25	1.55	1.65	1.15	1.60
7	1.65	2.80	2.20	2.40	1.75	2.15	1.30	2.00
9	1.85				2.30	2.20	1.65	2.35
10		3.10	2.35	2.65				
11	1.90				2.25	2.65	1.75	
	71	72	73	74	75	76	77	79
1	0.50	0.55	0.75	0.40	0.30	0.50	0.50	1.25
2	1.05	1.10	0.95	0.50	0.65	0.90	0.60	2.20
3	1.50	1.45	1.25	0.95	0.65	1.25	0.95	2.70
5	1.75	2.20	1.70	1.35	1.20	1.60	1.80	3.40
7	2.10	2.50	2.10	1.60	1.30	1.95	2.20	3.70
9			2.40	1.70	1.60			
10	2.20	2.70				2.30	2.45	4.00
11			2.70	1.90	1.70			
	79	80	81	82	83	84	85	86
1	0.70	0.90	0.40	0.55	0.45	0.45	0.65	0.35
2	0.80	1.40	0.80	0.95	0.60	0.90	0.70	0.60
3	1.05	1.80	0.90	1.20	0.90	0.95	0.80	0.90
5	1.60	2.60	1.05	1.70	1.55	1.75	1.15	1.20
7	2.05	2.80	1.35	2.10	2.00	1.90	1.50	1.60
9	2.05	3.15	1.60		2.10		1.70	1.85
10				2.60		2.35		
11		3.55	1.70				2.15	2.15

* See Appendix II, pages 10-15, Column 10

Long Term BOD Data (continued)

Days	Composite Number							
	87	88	89	90	91	92	93	94
1	0.60	0.55	0.25	0.40	0.70	1.35	0.30	1.00
2	0.90	0.95	0.27	0.70	0.75	1.55	0.55	1.50
3	0.85	1.40	0.42	0.85	0.85	1.95	0.50	1.90
5	1.25	1.80	1.25	1.65	0.90	2.50	0.90	2.40
7	1.65	2.30	1.60	1.90	1.35	2.85	1.00	2.90
9	1.85				1.50	3.10	1.20	
10		2.85	1.90	2.35				3.30
11	2.05				1.65	3.45	1.45	

Days	Composite Number	
	95	96
1	1.45	0.25
2	1.95	0.55
3	2.40	0.85
5	3.00	1.55
7	3.40	2.80
9		
10	3.70	2.30
11		

Short term BOD data - Averages of duplicate samples

1958 date	Time	River Mile*	D.O. ppm	Temp. °C	5-Day BOD	Short Term BOD 4	10	18	30 hrs.
		160.0							
8/25	0805	Left	7.50	26.5	1.23	0.00	0.06	0.26	0.78
	0803	Middle	7.50	26.7					
	0800	Right	7.40	26.7					
	1105	Left	7.65	27.0	2.14	0.10	0.35	0.57	0.89
	1103	Middle	7.35	27.0					
	1100	Right	7.20	27.5					
	1506	Left	8.00	28.0	1.67	0.00	0.16	0.48	0.62
	1503	Middle	7.85	28.0					
	1500	Right	7.65	28.0					
		158.0							
8/25	0825	Left	7.40	26.8	1.32	0.02	0.13	0.20	0.57
	0820	Middle	7.40	26.8					
	0820	Right	7.40	26.8					
	1125	Left	7.35	28.0	1.86	0.21	0.45	0.58	0.87
	1123	Middle	7.35	28.0					
	1120	Right	7.10	28.0					
	1530	Left	7.85	28.0	1.81	0.02	0.20	0.47	0.66
	1527	Middle	7.70	28.0					
	1525	Right	7.40	28.0					
		156.5							
8/25	0847	Left	7.30	26.9	1.06	0.02	0.23	0.37	0.68
	0844	Middle	7.20	26.9					
	0842	Right	7.20	26.6					
	1145	Left	7.20	28.0	2.15	0.26	0.45	0.51	0.80
	1143	Middle	7.10	28.0					
	1140	Right	7.00	28.0					
	1550	Left	7.45	28.0	2.37	0.06	0.35	0.66	0.90
	1547	Middle	7.35	28.5					
	1545	Right	7.35	28.5					

* Left, Middle, and Right indicate quarter point samples.

Short term BOD data - Averages of duplicate samples (continued)

1958 date	Time	River Mile*	D.O. ppm	Temp. °C	5-Day BOD	Short Term BOD 4	10	18	30 hrs.
		154.0							
8/25	0717	Left	7.11	29	1.45	0.05	0.28	0.30	0.60
	0715	Middle	7.16	29					
	0710	Right	7.08	29					
	1121	Left	7.14	29.2	1.21	0.02	0.26	0.16	0.46
	1118	Middle	7.16	29.2					
	1115	Right	7.05	29.2					
	1740	Left	7.51	29.4	1.93	0.11	0.30	0.55	0.65
	1735	Middle	7.39	29.4					
	1730	Right	7.21	29.4					
		149.5							
8/25	0753	Left	6.65	29.1	0.76	0.03	0.18	0.21	0.51
	0750	Middle	6.66	29.0					
	0746	Right	6.70	29.1					
	1153	Left	7.70	29.2	1.22	0.09	0.19	0.22	0.44
	1150	Middle	6.95	29.2					
	1148	Right	7.04	29.2					
	1820	Left	6.76	29.5	1.98	0.06	0.27	0.35	0.56
	1815	Middle	6.77	29.5					
	1810	Right	6.66	29.5					
		146.5							
8/25	0806	Left	6.50	29.1	1.10	0.10	0.17	0.22	0.50
	0803	Middle	6.51	29.1					
	0800	Right	6.51	29.1					
	1206	Left	6.89	29.3	1.30	0.14	0.16	0.20	0.35
	1203	Middle	6.84	29.3					
	1200	Right	6.80	29.3					
	1835	Left	6.63	29.4	1.98	0.10	0.15	0.36	0.59
	1830	Middle	6.58	29.4					
	1825	Right	6.59	29.4					

* Left, Middle, and Right indicate quarter point samples.

Coliform Organisms (Most Probable Number), Dissolved Oxygen, and Temperature by Date and Time of Sampling

1957 date	Time	River Mile	*Coliform (MPN)	D.O. ppm	Temp. °C
9/24	0600	160	240,000	7.60	26.0
	0645	158	93,000	7.45	26.0
	0735	154	240,000	6.65	26.0
	0905	146.5	1,100,000	6.20	26.0
	1030	138	93,000	6.35	26.0
	1105	133	1,100,000	6.70	26.0
	1220	120	43,000	8.50	26.0
	1440	113	93,000	9.55	26.0
	1550	97.5	24,000	9.85	26.5
9/25	0850	160	43,000	7.55	26.0
	0915	158	460,000	7.80	25.0
	1010	154	930,000	6.65	24.0
	1045	146.5	930,000	6.85	24.0
	1145	138	430,000	7.80	24.0
	1400	120	23,000	9.15	25.0
	1500	97.5	43,000	9.65	26.0
	1600	92	43,000	9.60	26.0
	1745	75	9,300	9.25	26.0
9/26	1730	160	1,100,000	7.80	24.5
	1715	158	390,000	8.30	25.0
	1640	154	430,000	7.95	24.0
	1600	146.5	930,000	7.80	24.0
	1530	140.5	430,000	6.35	24.0
	1500	133	240,000	8.35	24.5
	1345	120	43,000	9.50	24.5
	1245	97.5	9,300	9.85	24.5
	1130	92	43,000	9.85	24.0
	1015	75	21,000	8.25	24.0
9/27	1445	160	460,000	7.60	24.0
	1420	158	240,000	7.60	24.0
	1345	146.5	240,000	6.70	23.0
	1330	140.5	430,000	--	23.0
	1245	133	93,000	6.70	23.0
	1200	120	240,000	6.80	22.5
	1030	97.5	43,000	7.60	22.5
	1000	92	24,000	7.65	22.5
	0900	75	93.000	7.85	23.5

* Coliform Organisms per 100 ml.

Coliform Organisms (MPN), Dissolved Oxygen, Temperature (continued)

1957 date	Time	River Mile	*Coliform (MPN)	D.O. ppm	Temp. °C
10/10	1130	162.8	360	8.95	20.5
10/11	0215	162.8	910	8.70	20.5
10/10	1520	160.8	150,000	8.85	20.5
10/11	0245	160.8	93,000	8.85	20.5
10/10	1540	160	93,000	8.65	21.0
10/11	0305	160	23,000	8.65	20.5
10/10	1555	158	430,000	8.50	20.0
10/11	0320	158	36,000	8.60	21.0
10/5	1420	160	23,000	9.70	21.0
	1400	158	43,000	8.20	21.0
	1315	152	93,000	8.55	21.0
	1225	146.5	43,000	8.20	20.0
	1100	138	35,000	8.15	20.0
	1045	133	240,000	7.95	20.0
	0945	120	93,000	7.45	20.0
10/8	0815	160	9,100	8.75	20.0
	0830	158	11,000	8.60	20.0
	0905	154	150,000	8.40	20.0
	1015	146.5	930,000	7.90	20.0
	1115	138	39,000	7.75	20.0
	1135	133	430,000	7.85	20.0
	1215	120	93,000	7.45	20.0
	1435	97.5	43,000	8.05	20.0
10/14	0800	146.5	930,000	7.55	18.0
	1200	146.5	240,000	8.30	20.0
	1600	146.5	150,000	8.40	21.0
	2000	146.5	430,000	8.30	20.5
	2400	146.5	240,000	7.40	19.0
10/15	0400	146.5	430,000	7.20	19.0
	0700	146.5	430,000	7.60	19.0

* Coliform Organisms per 100 ml.

Coliform Organisms (MPN), Dissolved Oxygen, Temperature (continued)

1958 date	Time	River Mile	*Coliform (MPN)	D.O. ppm	Temp. °C
8/21	0600	162.8	240	6.95	26.0
	1015	160.0	43,000	7.50	27.5
	1030	158.0	430,000	7.45	27.0
	1055	154.0	430,000	6.95	27.5
	1015	146.6	93,000	6.40	29.0
	1040	318.0	390,000	6.10	29.0
	1100	133.0	390,000	6.05	29.0
8/26	0945	162.8	7,500	6.75	26.0
	1045	160.3	93,000	7.30	26.0
	1100	160.0	91,000	7.35	26.0
	1120	154.0	230,000	7.00	26.5
	1200	146.5	240,000	6.80	26.5
	1105	138.0	230,000	6.40	28.0
	1130	133.0	1,500,000	6.45	28.0
	1150	128.0	430,000	6.30	27.5
	1215	120.0	1,500,000	6.15	27.5
	1255	108.0	93,000	6.30	28.0
	1420	92.0	93,000	6.20	28.0
	1510	75.0	43,000	6.75	27.5
8/27	1000	162.8	24,000	7.30	26.5
	1115	160.3	150,000	7.30	27.0
	1210	160.0	240,000	7.30	27.5
	1230	154.0	1,500,000	6.75	27.5
	1300	146.5	430,000	6.95	28.0
	1105	138.0	430,000	6.50	27.0
	1125	133.0	930,000	6.55	27.0
	1137	128.0	930,000	6.45	27.0
	1200	120.0	430,000	6.15	27.0
	1240	108.0	93,000	6.75	27.5
	1440	92.0	43,000	6.90	28.0
	1530	75.0	43,000	6.60	28.0
9/1	0815	162.8	4,300	7.00	26.0
	0925	160.3	23,000	7.30	27.0
	0945	160.0	23,000	7.40	27.0
	1005	154.0	23,000	7.20	28.0
	1040	146.6	93,000	6.90	28.0
	0930	138.0	75,000	6.60	28.0
	1000	133.0	230,000	6.70	27.5
	1030	128.0	430,000	6.70	27.5
	1100	120.0	230,000	6.70	28.0
	1130	108.0	93,000	7.00	28.5
	1300	92.0	23,000	7.30	28.5
	1400	75.0	9,100	7.50	29.0

* Coliform Organisms per 100 ml.

Flow Data - Gauge Station Flows and Adjusted Downstream Flows Corresponding to Composited Samples

1957 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
9/16	1030	160	1220	None				
	1450		1400					
	1840		1400		1300	0	1300	1a
	2400	160	1530	None				
9/17	0650		1400					
	0650		1400		1450	0	1450	1b
9/16	0955	158	1220	1130				
	1425		1440	1310				
	1820		1440	1400	1350	35	1385	2a
	2300	158	1400	1400				
9/17	0620		1450	1450				
	0620		1450	1450	1450	35	1585	2b
9/16	0915	154	1220	1220				
	1350		1310	1220				
	1750		1400	1310	1250	50	1300	3a
	2230	154	1400	1400				
	0420		1445	1445				
	0420		1445	1445	1450	50	1500	3b
9/16	0830	146.5	1175	1530				
	1305		1310	1400				
	1715		1400	1310	1400	125	1525	4a
	2135	146.5	1400	1220				
9/17	0420		1445	1400				
	0420		1445	1400	1350	125	1475	4b
9/16	0730	138	1130	1400				
	1210		1265	1445				
	1625		1490	1445	1450	200	1650	5a
	2040	138	1490	1445				
9/17	0315		1445	1175				
	0315		1445	1175	1250	200	1450	5b

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and Adjusted Downstream Flows (continued)

1957 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
9/17	1120	160	1530	None		0		
	1435		1890					
	1730		2460		1900		1900	6a
	2130	160	2640	None		0		
9/18	0040		2680					
	0500		2600		2650		2650	6b
9/17	1055	158	1400	1310				
	1410		1890	1490				
	1710		2390	2320	1700	35	1735	7a
	2120	158	2600	2600				
	2400		2680	2680				
9/18	0400		2250	2530	2600	35	2635	7b
9/17	1020	154	1490	1400				
	1305		1445	1310				
	1640		2390	1650	1450	50	1500	8a
	2020	154	2600	2460				
	2335		2680	2530				
9/18	0400		2250	2680	2550	50	2600	8b
9/17	0940	146.5	1310	1400				
	1125		1490	1400				
	1610		2390	1445	1400	125	1525	9a
	1925	146.5	2530	1310				
	2255		2680	1490				
9/18	0310		2460	2390	1700	125	1825	9b
9/18	0825	160	1730	None				
	1150		1650					
	1650		1970		1750	0	1750	10a
	2215	160	5440	None				
9/19	0205		5000					
	0600		3900		4800	0	4800	10b

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and Adjusted Downstream Flows (continued)

1957 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
9/18	0805	158	1810	1810				
	1125		1650	1570				
	1620		2600	2320	1900	35	1935	11a
	2145	158	5560	5560				
9/18	0140		5000	5210				
	0520		4270	4450	5100	50	5150	11b
9/18	0730	154	1810	1890				
	1105		1650	1730				
	1540		2600	1650	1750	50	1800	12a
	2030	154	5440	3910				
9/19	0100		5560	5440				
	0445		4450	4900	4700	125	4825	12b
9/18	0700	146.5	1890	2530				
	1010		1650	2680				
	1425		2390	2460	2550	125	2675	13a
	1930	146.5	5210	1570				
	2400		5680	2320				
9/19	0400		4900	3400	2400	125	2525	13b
9/19	0850	160	3240	None				
	1230		3000					
	1745		5320		3800	0	3800	14a
	2100	160	5100	None				
9/20	0215		4900					
	0500		4720		4900	0	4900	14b
9/19	0830	158	3320	3400				
	1210		2920	2920				
	1730		5320	5320	3850	50	3900	15a
	2030	158	5000	5000				
	2400		4900	4900				
9/20	0430		4900	4900	4950	75	5025	15b

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and Adjusted Downstream Flows (continued)

1957 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
9/19	0800	154	3640	4500				
	1140		3000	3400				
	1640		5210	3240	3700	100	3800	16a
	1950	154	5210	5440				
	2315		5000	5100				
9/20	0345		4900	4950	5100	125	5225	16b
9/19	0720	146.5	3730	5680				
	1100		3000	5000				
	1530		5560	4090	4900	800	5700	17a
	1900	146.5	5440	3160				
	2230		4950	2920				
9/20	0255		4950	5210	3750	700	4450	17b
9/23	0910	162.8	1730	2680				
	1300		1650	2680				
	1700		2285	2680	2680	0	2680	18
9/23	0815	160.8	1730	2250				
	1205		1650	1650				
	1615		2320	2390	2100	0	2100	19
9/23	0830	160	1730	None				
	1220		1650					
	1630		2250		1850	0	1850	20
10/3	1020	160	3820	None				
	1450		4810					
	1750		5000		4500	0	4500	21
10/3	1000	158	3400	3400				
	1430		4810	4810				
	1730		5000	5000	4400	75	4475	22
10/3	1350	154	4810	3480				
	1640		5000	3480	3480	100	3580	23
10/3	0850	146.5	3320	6170				
	1240		4450	5210				
	1630		5000	3640	4900	800	5700	24

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and Adjusted Downstream Flows (continued)

1957 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
10/3	1030	133	3400	5800				
	1440		4540	5800	5800	900	6700	25
10/3	0930	120	3400	3320				
	1320		4630	3160	3250	1200	4350	26
10/3	0845	97.5	3560	4270				
	1220		4000	5050	4600	1500	7100	27
10/4	0930	160	5000	None				
	1345		5100					
	1715		5100		5100	0	5100	28
10/4	0915	158	5000	5000				
	1320		5100	5100				
	1645		5100	5100	5100	50	5150	29
10/4	0840	154	5000	5100				
	1240		5100	5000				
	1600		5100	5000	5050	100	5150	30
10/4	0745	146.5	5000	5000				
	1200		5000	5000				
	1515		5000	5000	5000	550	5550	31
10/4	1010	138	5000	5050				
	1435		5100	5100	5050	900	5950	32
10/4	1030	133	5050	5000				
	1500		5050	5050	5000	900	5900	33
10/4	1120	120	5050	3820				
	1545		5100	4900	4350	1600	5950	34
10/5	0945	160	5000	None				
	1420		5000					
	1700		5560		5150	0	5150	35
10/5	0850	158	5000	5000				
	1400		5000	5000				
	1540		5440	5320	5150	50	5200	36

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and
Adjusted Downstream Flows (continued)

1957 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
10/5	0830	154	5050	5680				
	1315		5000	5050				
	1600		5000	5000	5250	100	5350	37
10/5	0755	146.5	5050	5800				
	1225		5050	5210				
	1520		5320	5050	5300	250	5550	38
10/5	1100	138	5050	5050				
	1515		5050	5100	5050	900	5950	39
10/5	1045	133	3160	5100				
	1340		4720	5100	5100	900	6000	40
10/5	0945	120	5050	5050				
	1300		5050	5050	5050	1600	6650	41
10/9	0800	162.8	2920	4270				
	1045		2840	3400				
	1415		4360	3160				
	1710		3730	3120	3500	0	3500	42a
	2000	162.8	3200	3080				
	2300		3080	2530				
10/10	0200		3120	2320				
	0500		2760	1970	2500	0	2500	42b
10/9	0830	160.8	2920	2920				
	1110		2840	2840				
	1450		3820	3820				
	1730		3640	3640	3300	0	3300	43a
	2230	160.8	3160	3160				
	2320		3160	3160				
10/10	0230		3080	3080				
	0530		2760	2760	3050	0	3050	43b
10/9	0900	160	3000	None				
	1130		2840					
	1515		4180					
	1750		4180		3700	0	3700	44a

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and Adjusted Downstream Flows (continued)

1957 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
10/9	2115	160	3160	None				
	2400		3240					
10/10	0300		3080					
	0600		2680		3000	0	3000	44b
10/9	0920	158	3000	3000				
	1150		2840	2840				
	1540		4270	4270				
	1810		3640	3720	3550	50	3600	45a
	2130	158	3100	3100				
10/10	0020		3240	3240				
	0315		3080	3080				
	0615		2600	2080	3000	50	3050	45b
10/10	0800	162.8	2320	2640				
	1100		2460	2680				
	1450		2760	2390				
	1650		2600	2460	2500	0	2500	46a
	2000	162.8	2680	1850				
	2300		2680	1730				
10/11	0215		2600	1650				
	0445		2110	2460	1900	0	1900	46b
10/10	0830	160.8	2390	2390				
	1115		2460	2460				
	1520		2680	2680				
	1720		2680	2680	2600	0	2600	47a
	2100		2680	2680				
	2300		2680	2680				
10/11	0245		2530	2460				
	0500		1890	1890	2450	0	2450	47b
10/10	0850	160	2320	None				
	1130		2530					
	1540		2680					
	1730		2600		2500	0	2500	48a

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and
Adjusted Downstream Flows (continued)

1957 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
	2130	160	2680	None				
	2400		2680					
10/11	0305		2320					
	0530		1890		2400	0	2400	48b
10/10	0905	158	2320	2320				
	1150		2600	2530				
	1555		2680	2680				
	1745		2600	2600	2500	50	2550	49a
	2140	158	2680	2680				
10/11	0015		2680	2680				
	0320		2110	2250				
	0545		1810	1850	2400	50	2450	49b
10/16	0845	160	1890	None				
	1000		2460					
	1520		2680		2300	0	2300	50
10/16	1030	146.5	2390	2530				
	1315		2680	2600				
	1600		2760	1490	2200	125	2325	51
10/16	0950	120	2530	2530				
	1420		2760	2600	2550	250	2800	52
10/16	1530	97.5	2760	3160	3150	2300	5450	53
10/16	1110	92	2600	2840	2850	2500	3300	54

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and Adjusted Downstream Flows (continued)

1958 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
8/14	1825	162.8	6040	6170				
	2225		6170	6240				
8/15	0200		6240	5210	5870	0	5870	55
8/14	1855	160.0	6110	None				
	2300		6170					
8/15	0225		6240		6170	0	6170	56
8/14	1905	158.0	6110	6040				
	2315		6170	6170				
8/15	0245		6240	6240	6150	35	6185	57
8/14	1925	154.0	6110	5920				
	2350		6170	6170				
8/15	0315		6240	6170	6090	65	6155	58
8/14	1840	146.5	6110	3080				
	2140		6170	4600				
8/15	0200		6240	5980	4550	460	4960	59
8/14	1905	138.0	6110	3560				
	2215		6170	3160				
8/15	0230		6240	4270	3660	750	4410	60
8/14	1920	133.0	6170	5100				
	2315		6170	3560	4330	800	5130	61
	--							
8/15	1755	162.8	6170	6240				
	2205		6240	5920				
8/16	0200		5920	5100	5750	0	5750	62
8/15	1835	160.0	6170	None				
	2240		6240					
8/16	0235		5680		6030	0	6030	63
8/15	1845	158.0	6170	6130				
	2255		6240	6240				
8/16	0250		5560	5680	6020	35	6055	64
8/15	1915	154.0	6170	6040				
	2320		6240	6170				
8/16	0310		5560	6170	6130	50	6190	65

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and Adjusted Downstream Flows (continued)

1958 date	Time	River Mile	*Gauge (cfs)	Adjusted (cfs)	Mean Adjusted (cfs)	Tributary (cfs)	Final Adjusted (cfs)	Composite No.
8/15	1800	146.5	6140	3480				
	2230		6240	5800				
8/16	0400		5000	6170	5150	400	5550	66
8/15	1925	138.0	6170	4900				
8/16	0110		6170	3480				
	0300		5560	5560	4650	650	5300	67
8/15	2030	133.0	6170	6240				
8/16	0210		5800	3640				
	0230		5680	3400	4430	680	5110	68
8/16	1755	162.8	6110	6170				
	2155		6170	4180				
8/17	0200		4180	2840	4400	0	4400	69
8/16	1835	160.0	6110	None				
	2225		6110					
8/17	0225		4090		5440	0	5440	70
8/16	1850	158.0	6110	6110				
	2240		6110	6170				
8/17	0240		3910	4180	5490	35	5525	71
8/16	1905	154.0	6110	6040				
	2300		5920	6110				
8/17	0300		3730	5210	5790	50	5840	72
8/16	1800	146.5	6110	3160				
	2200		6170	5680				
8/17	0130		4540	6040	4960	350	5310	73
8/16	1905	138.0	6110	4090				
	2300		5920	3160				
8/17	0200		4180	5320	4190	600	4790	74
8/16	1925	133.0	6170	4090				
	2330		5800	3320				
	0220		4090	5560	4320	630	5950	75

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and
Adjusted Downstream Flows (continued)

1958 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
8/19	0555	162.8	4950	3730				
	1000		3730	5680				
	1400		5680	5100	4840	0	4840	76
8/19	0705	160.0	4720	None				
	1050		3690					
	1440		5800		4740	0	4740	77
8/19	0720	158.0	4680	4810				
	1110		4000	3690				
	1450		5800	5800	4770	20	4790	78
8/19	0750	154.0	4540	4950				
	1135		4000	4090				
	1515		5800	5210	4750	30	4780	79
8/19	0630	146.5	4900	4950				
	1030		3690	5000				
	1330		5560	4950	4970	180	5150	80
8/19	0710	138.0	4720	4810				
	1100		3820	4950				
	1400		5680	4000	4590	300	4890	81
8/19	0745	133.0	4540	4770				
	1120		3910	4810				
	1415		5680	4950	4840	320	5160	82
8/20	0600	162.8	3730	3000				
	1000		3000	4540				
	1355		4540	4900	4150	0	4150	83
8/20	0700	160.0	3400	None				
	1030		3080					
	1420		4540		3670	0	3670	84
8/20	0720	158.0	3320	3480				
	1045		3160	3000				
	1440		4680	4540	3670	30	3700	85

* Gauge at Central of Georgia Railroad Bridge

Flow Data - Gauge Station Flows and
Adjusted Downstream Flows (continued)

1958 date	Time	River Mile	*Gauge (cfs)	Ad-justed (cfs)	Mean Adjusted (cfs)	Tribu-tary (cfs)	Final Adjusted (cfs)	Com-posite No.
8/20	0745	154.0	2530	4000				
	1115		3320	3160				
	1505		4720	4090	3750	40	3790	86
8/20	0630	146.5	3480	5000				
	0930		3080	4950				
	1315		4450	4000	4650	270	4920	87
8/20	0700	138.0	3480	5100				
	1005		3000	5000				
	1315		4360	4950	5020	430	5450	88
8/20	0715	133.0	3400	5680				
	1020		3000	5320				
	1355		4540	5000	5330	460	5790	89
8/21	0600	162.8	3560	3160				
	0945		3160	4540				
	1405		4630	4810	4170	0	4170	90
8/21	0655	160.0	3320	None				
	1015		3160					
	1340		4450		3640	0	3640	91
8/21	0715	158.0	3320	3400				
	1030		3240	3160				
	1500		4810	4770	3780	20	3800	92
8/21	0735	154.0	3280	3820				
	1055		3320	3200				
	1520		4770	4360	3790	30	3820	93
8/21	0645	146.5	3400	4950				
	1015		3160	4810				
	1330		4450	3730	4500	220	4720	94
8/21	0715	138.0	3320	4900				
	1040		3240	4900				
	1400		4630	4900	4900	360	5260	95
8/21	0730	133.0	3280	4630				
	1100		3320	4900				
	1415		4630	4950	4460	390	4850	96

* Gauge at Central of Georgia Railroad Bridge

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Analysis of Outfall Wastes and Waste Effluents

Sewer Location	Discharge cfs	MGD	BOD ppm	# BOD per day	Population Equivalent
Columbus Sewers (Below Eagle Phenix Dam)					
12th Street	0.72	0.47	122	475	2,850
11th Street	3.36	2.18	96	1,720	10,400
9th Street	0.80	0.52	190	830	5,000
7th Street	3.35	2.17	278	5,070	30,000
5th Avenue	5.53	3.57	295	8,800	52,500
Bull Creek	1.08	0.69	190	1,110	6,630
Muscogee Co.	2.88	1.86	124	1,930	11,600
Phenix City Sewers					
29th Street	0.025	0.06	305	40	240
25th Street	0.0250	0.06	305	40	240
18th Street	0.450	0.29	330	785	4,700
16th Street	0.230	0.15	460	575	3,440
15th Street	0.032	0.21	32	32	185
N. Holland Creek	0.735	0.48	232	920	5,500
S. Holland Creek	0.496	0.32	152	407	2,450
Dillingham Street	0.250	0.16	273	370	2,200
Eufaula Sewer					
	0.58	0.37	210	653	3,950

Analysis of Outfall Wastes and Waste Effluents (continued)

Textile Mill Waste

Mill Effluent A

Date - 10/22/57
Time - 0800, 1200, 1500 (Composited)
pH - 11.45
BOD - 80.0 ppm
Dissolved Solids - 866 ppm
Pumpage - 1400 GPM

Mill Effluent B

Date - 10/22/57
Time - 1000, 1300, 1600 (Composited)
pH - 10.70
BOD -111.1 ppm
Dissolved Solids - 1,220 ppm
Pumpage - 1600 GPM

APPENDIX IV

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Deoxygenation Velocity Constants 48

Deoxygenation Velocity Constants (k_1 20°)

River Mile	1957(1) k_1 Values	1958(2) k_1 Values
162.8 - 160	0.30	--
160.0 - 154	0.57	0.76 (a)
154.0 - 146.5	0.22	0.33 (b)
146.5 - 138	0.17	0.28 (b)

(1) Derived from river data @ 1,700 cfs. Values obtained from plots of ultimate first stage BOD values against time (time of river travel between stations) on semi-log quadrants and solving the resultant slope by the following formula:

$$k_1 = -\frac{1}{t} \text{ Log } \frac{L_B}{L_A}$$ in which

L_B = Ultimate first stage BOD at downstream Station B

L_A = Ultimate first stage BOD at source of pollution or some intervening point above Station B.

(2) Derived from time analysis of BOD satisfaction under controlled conditions in laboratory.

(a) Short term BOD analysis (hourly)

(b) Long term BOD analysis (daily)

Values computed from plots of consecutive differences in BOD values obtained from short or long term BOD analysis on semi-log quadrants and solving for k_1 by the following formula:

$$k_1 = \frac{2 - \log \text{ \% BOD Remaining}}{t}$$ in which

$$\text{\% BOD Remaining} = \frac{\text{Difference at time (t)}}{\text{Difference at intercept}} \times 100.$$

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River Data Immediately Above and Below Tributaries and Sewer Outfalls 51

Impoundment Studies - August 18, 1958

Station and Measurement	Cross-section Location	Sample Time	Sample Depth* (feet)	Temp. °C	D.O. (ppm)	BOD 5-Day (ppm)	MPN Coli./ 100 ml.
City Mills Impoundment	Left	1125	4	28.5	6.90		
River Mile - 162.3		1120	14	28.0	6.90	0.70	----
Cross-sectional area - 10,500 sq. ft.							
Average Velocity - 0.43 fps	Middle	1135	2	28.5	6.80		
Discharge - 4,700 cfs		1130	7	28.0	6.70	0.85	9,300
	Right	1150	2	28.5	6.60		
		1145	7	28.0	6.65	0.85	----
City Mills Impoundment	Left	1020	2	28.0	6.85		
River Mile - 161.7		1015	6	28.0	6.65	0.90	----
Cross-sectional area - 7,050 sq. ft.							
Average Velocity - 0.64 fps	Middle	1040	2	28.0	6.80		
Discharge - 4,500 cfs		1035	6	28.0	6.80	0.55	24,000
	Right	1050	2	28.0	6.75		
		1045	7	28.0	6.85	0.90	----
Eagle Phenix Impoundment	Left	1535	2	29.5	7.70	1.10	----
River Mile - 161.2							
Cross-sectional area - --	Middle	1530	2	29.5	7.70	1.30	24,000
Average Velocity - --							
Discharge - 4,700 cfs	Right	1525	2	29.0	7.40	2.20	----
Eagle Phenix Impoundment	Left	1600	4	29.5	7.75		
River Mile - 160.8		1555	14	29.5	7.65	1.10	----
Cross-sectional area - 7,250 sq. ft.							
Average Velocity - 0.66 fps	Middle	1640	3.5	29.0	7.65		
Discharge - 4,800 cfs		1635	12	29.5	7.70	1.10	43,000
	Right	1700	2	29.5	7.15	1.25	----

* Where two depths are given the samples were collected at 0.2 and 0.7 of total depth, respectively.

Tributary Data

Tributary*	1958 date	River Mile	Sample Time	Temp. °C	D.O. ppm	BOD 5-Day ppm
Holland Creek	8/22	160.1	0920	24.0	4.90	25.20
Bull Creek	8/12	157.0	0900	26.0	5.70	---
	8/22	157.0	1015	26.0	3.65	114.00
Cochgaheghee Creek	8/22	155.0	1045	23.5	7.70	1.15
Upatoi Creek	8/12	150.0	0950	27.5	7.20	
	8/22	150.0	1130	26.5	7.50	0.95
Uchee Creek	8/22	143.5	1255	28.0	6.70	1.15
Hitchitee Creek	8/22	132.5	1400	27.0	7.35	---

* Samples collected at mouth.

River data immediately above and below tributaries and sewer outfalls

Sampling Point	1958 date	River Mile	Sample Time	Temp. °C	D.O. ppm	BOD 5-Day ppm
Below Dillingham St. Outfall - P.C.	8/22	160.0	0940	27.0	7.30	2.10
Above 5th Avenue Outfall - Col.	8/22	158.8	0950	27.5	7.20	0.90
Below 5th Avenue Outfall - Col.	8/22	158.8	0957	27.5	6.55	76.55
Above Bull Creek	8/22	157.0	1005	27.5	6.90	1.25
Below Bull Creek	8/22	157.0	1027	27.5	6.70	1.35
Below Muscogee County Outfall	8/22	156.9	1032	27.5	6.50	1.75
Above Cochgaheghee Creek	8/22	155.0	1045	27.5	7.20	0.90
Below Cochgaheghee Creek	8/22	155.0	1100	28.0	7.05	0.90
Above Upatoi Creek	8/22	150.0	1125	28.5	6.95	0.75
Below Upatoi Creek	8/22		1140	27.0	7.35	0.40
Above Ft. Benning Pressure Sewer	8/22	148.0	1150	28.0	6.85	0.75
Below Ft. Benning Pressure Sewer	8/22	148.0	1155	28.0	6.80	2.60
Above Ft. Benning So. Interceptor	8/22	145.0	1215	28.0	6.50	0.85
Below Ft. Benning So. Interceptor	8/22	145.0	1220	28.0	6.50	1.10
Above Uchee Creek	8/22	143.5	1235	28.5	6.60	0.90
Below Uchee Creek	8/22	143.5	1255	29.0	6.70	1.15